Collaborate or Perish:

Harnessing Strategic Drivers to Navigate the Circular Economy Transition

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UiA University of Agder

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To my beloved family, to my caring parents.

Who have always stood by me,

to whom I owe my accomplishments

and what I have become.

Preface

This research project was born out of my personal curiosity about circular economy, wondering how business management has to adapt to cope with major environmental challenges. Then, it took shape as a result of numerous changes of direction, setbacks and breakthroughs, which characterised my doctoral journey. Some studies took years of intellectual effort, several times it was necessary to tear up the paper and start from a new blank page; while others, born under a lucky star, required a few months of development. Eventually, each phase of my research project took its own time to evolve into the articles that make up this dissertation.

In putting together these pages, representing some of the products of my research over the last few years, I decided to place them under the umbrella of a provocative title. Drawn from a speech by Antonio Guterres at the United Nations Annual Climate Conference in 2022, “Collaborate or Perish” embodies the major takeaway of this dissertation. It is intended to be a key to understanding the whole manuscript, since a collaborative approach underpins the findings discussed in the studies that follow. In the next chapters, I seek to contribute to such debate by investigating the strategic drivers that facilitate the adoption of circular economy principles in businesses, emphasizing the role of collaboration, innovation, and digital technologies. As a result, this thesis offers an overview of how managers are required to look beyond firm boundaries to embrace sustainable economic growth.

Abstract

In an era marked by burgeoning environmental concerns and resource depletion, integrating economic growth with sustainable development has become imperative. In response, this research project dwells on circular economy as a strategic approach that promotes a shift from traditional production and consumption systems to restorative and renewable ones. Through four distinct studies, I investigated the practices driving circular principles' adoption in businesses, winking at inter-organisational collaborative approaches. The dissertation includes a systematic literature review, two multiple case studies with differing philosophical positions, and deductive research based on structural equation modelling. As a result, it recognises and clarifies some critical drivers of circular economy adoption in businesses, which are enabled and empowered by a multistakeholder approach. Findings highlight the importance of strategic collaboration, open innovation, and digital technologies in encouraging circular products, processes, and practices development in collaborative business models. Each study made a specific contribution to the literature by wearing different theoretical lenses, including the resource-based view of the firm, stakeholder theory, and institutional theory. In terms of practical implications, this dissertation provides valuable insights into the strategic drivers and collaborative practices essential for achieving sustainable development and pursuing the circular economy transition.

Sammendrag

I en tid preget av økende miljøproblemer og ressursuttømming er det blitt helt nødvendig å integrere økonomisk vekst med bærekraftig utvikling. Dette forskningsprosjektet tar derfor for seg sirkulær økonomi som en strategisk tilnærming som fremmer et skifte fra tradisjonelle produksjons- og forbrukssystemer til gjenopprettende og fornybare systemer. Gjennom fire ulike studier har jeg undersøkt hvilke praksiser som driver frem innføringen av sirkulære prinsipper i bedrifter, og jeg har sett nærmere på interorganisatoriske samarbeidstilnærminger. Avhandlingen omfatter en systematisk litteraturgjennomgang, to casestudier med ulike filosofiske ståsteder og deduktiv forskning basert på strukturell ligningsmodellering. Som et resultat av dette anerkjenner og tydeliggjør avhandlingen noen kritiske drivkrefter for innføring av sirkulær økonomi i bedrifter, noe som muliggjøres og styrkes av en flerpartstilnærming. Funnene fremhever betydningen av strategisk samarbeid, åpen innovasjon og digital teknologi for å fremme utvikling av sirkulære produkter, prosesser og praksis i samarbeidende forretningsmodeller. Hver studie bidro spesifikt til litteraturen ved å bruke ulike teoretiske briller, blant annet det ressursbaserte synet på bedriften, interessentteori og institusjonell teori. Når det gjelder praktiske implikasjoner, gir denne avhandlingen verdifull innsikt i de strategiske drivkreftene og samarbeidspraksisene som er avgjørende for å oppnå en bærekraftig utvikling og gjennomføre overgangen til sirkulær økonomi.

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CHAPTER ONE

Introduction to the Doctoral Dissertation

1.1 Motivation of the Dissertation and Positioning

In an era marked by burgeoning environmental concerns and escalating resource depletion, the imperatives of sustainable development concurrent with economic growth have become increasingly noticeable. Due to the pressure of traditional economic systems and irresponsible consumption on the world, mankind is facing grand challenges such as global warming, environmental depletion, biodiversity loss, pollution, and waste management (Intergovernmental Panel on Climate Change, 2018; United Nations Environment Programme, 2024a). The economic system in force in recent decades has led to redundancies that can no longer go unnoticed, think of the 2.1 billion tonnes of waste produced in 2023, which is supposed to rise to 3.8 billion tonnes yearly generated in 2050 (United Nations Environment Programme, 2024c), or the market failure resulting from throwing away more than 1 trillion dollar worth of food every year by generating almost 10% of global greenhouse gas emissions (United Nations Environment Programme, 2024a). Overall, The Circularity Gap Report 2024 points out how the global economy has consumed 582 billion tonnes of materials in the period 2016-2021, which is nearly as many materials as the 740 billion tonnes consumed in the entire 20th century. As a result, "this puts unsustainable pressure on Earth's ecosystems and biocapacity, far more than we need to equitably fulfill many societal needs" (Circle Economy & Deloitte, 2024, p. 19). These phenomena are symptoms of unsustainable growth, while Mother Nature is crying out for the need to address a new paradigm of production and consumption.

Amidst this backdrop, the concept of a circular economy (CE) has emerged as an approach to achieve corporate sustainability, encompassing a systemic arrangement to economic development that benefits businesses, society, and the environment (Ellen MacArthur Foundation, 2013; European Commission, 2020; United Nations Environment Programme, 2024b). It entails a paradigmatic shift that proposes production and consumption patterns reconfiguration from the traditional linear model to a regenerative and restorative one (Geissdoerfer et al., 2017; Kirchherr et al., 2023; Korhonen et al., 2018). At its essence, the shift towards a circular arrangement necessitates a systemic overhaul of prevailing

economic development paradigms. Unlike the linear economy, which perpetuates a pattern of resource extraction, production, consumption, and disposal, CE seeks to decouple economic growth from resource consumption, fostering regenerative loops where exhausted products and waste are fed back into the system. This fundamental restructuring holds profound implications not only for businesses but also for society at large. From mitigating environmental depletion to enhancing resource efficiency and fostering economic resilience, the adoption of CE principles stands as a linchpin for sustainable development in the 21st century.

Within the domain of business management literature, the study of CE occupies a pivotal niche, straddling the intersecting domains of corporate sustainability, innovation, and strategic management (Bocken et al., 2016; Centobelli et al., 2020; Jesus & Jugend, 2023; Suchek et al., 2021). Traditionally, business management studies have been grounded on a linear, growth-oriented paradigm, wherein success is often equated with maximizing shareholder value and optimizing operational efficiency. In contrast, the wide debate surrounding CE disrupts this conventional wisdom, challenging businesses to reconceptualize value creation, capture, and delivery in more holistic and autopoietic terms.

Previous studies outlined specific business models that incorporate CE principles (i.e., circular business models) in terms of the adoption of narrowing, slowing, and/or closing strategies to stem resources and energy flows (Bocken et al., 2016; Geissdoerfer et al., 2018). Accordingly, these economic organisations seek to thrive while minimising their environmental and social negative impacts, or by attempting to deliver clever solutions to face actual problems. For instance, when companies undertake creative ways of replacing raw materials with recovered production waste, even engaging in cross-industry collaborations (Perotti et al., 2024). CE principles are thus typically implemented in businesses as a series of practices integrated into the design, transformation, consumption, and disposal stages of products and services development to establish a renewable system (Ellen MacArthur Foundation, 2013; Perotti et al., 2023). They include rethinking consumption patterns and reducing resource and energy use, thereby preventing waste at the source (Geissdoerfer et al., 2018). Reusing, repairing, and refurbishing products extend their lifespan, while remanufacturing and repurposing transform old items into new ones (Hopkinson et al., 2018; Chaudhuri et al., 2022). Finally, recycling and recovering materials ensure that any remaining waste is processed into new resources, maintaining the cycle and reducing environmental impact

(Bocken et al., 2016; Franzò et al., 2021). In sum, such an approach to business management aims to keep products, materials, and resources in use for as long as possible, thus reducing environmental impact, conserving resources, and fostering sustainability.

At the heart of the circular transition lies the necessity for businesses to collaborate, innovate by looking beyond the firm's boundaries, and harness digital technologies as strategic levers for embracing the principles of circularity (De Angelis et al., 2023; Perotti et al., 2023; Zucchella & Previtali, 2019). In their systematic literature review, Suchek et al. (2021) pointed out how alliances are a thematic area that deserves further exploration between circular economy and innovation management literature. Other authors (e.g., Jesus & Jugend, 2023; Köhler et al., 2021; Perotti et al., 2024) also supported the relevance of the nexus link between open innovation and circular economy, as a viable strategy to achieve sustainable development. In this vein, collaboration with external stakeholders enables the incorporation of circular principles and practices (Tapaninaho & Heikkinen, 2022), leveraging external key resources, knowledge, and skills to deal with barriers to the implementation of sustainable innovation (Galvão et al., 2022; Seles et al., 2022; Wade et al., 2022). Therefore, in order to take advantage of sustainability opportunities (Averina et al., 2022) by implementing circular-oriented innovations (Blomsma et al., 2019; Brown et al., 2019), collaboration is not just a strategic choice but an imperative. Supporting this reasoning, past authors explored supply chains (Farooque et al., 2019; Sudusinghe & Seuring, 2022; Tseng et al., 2022), ecosystems (Konietzko et al., 2020; Zucchella & Previtali, 2019), and industrial symbiosis (Baldassarre et al., 2019; Yu et al., 2021) as fertile grounds in which to growth CE. However, there are several opportunities to enrich this literature stream by specifically focusing on which conditions can promote the development of collaborative circular business models. According to these premises, the research question of this doctoral thesis is the following: *what are the main drivers for the adoption of CE principles in businesses through the benefits of collaborative systems?*

In response, this doctoral dissertation seeks to delve into some critical dimensions – i.e., business collaboration, innovation management, and digital technologies – to outline several substantiated strategic approaches aimed at enabling and facilitating the adoption of CE principles in businesses. Through four distinct studies, the research project behind this dissertation sought to elucidate the

nuanced dynamics underpinning this transformative journey towards sustainable development. In the following sections, the four scientific articles that compose this doctoral dissertation are presented by disclosing the research project's design, the main general findings, and a concise presentation of the overall contribution of the doctoral endeavour.

1.2 Objectives and Research Project Design

The research design of this doctoral dissertation encompasses four interconnected studies, each employing distinct methodologies to contribute to the comprehensive understanding of the mechanisms that trigger the adoption of CE principles in businesses. First, a systematic literature review offers an initial comprehensive assessment and systematisation of the literature on the topic, as well as some key findings for further studies. An empirical article will then follow, in the form of two inductive studies based on the multiple case study methodology, yet different considering the philosophical underpinnings and the outcomes of both scientific articles. Finally, a deductive-based empirical study uses the structural equation modeling technique to quantitatively validate some of the theoretical constructs and relationships identified in the previous studies, in addition to delivering generalisable findings to academics and practitioners. As a result, the integration of various methodologies offers a multifaceted approach to addressing the above research question, enabling a robust exploration of the topic from various perspectives. A brief description of each study is offered below.

1.2.1 Research paper 1: Systematic Literature Review

The first study, carried out as a systematic literature review, aims at synthesizing and structuring existing academic papers about CE in the business management domain. More specifically, referring to inter-organizational collaborations and drivers that trigger businesses' circular transition by leveraging relationships with external actors. This methodology provides a structured approach to collecting, analysing, and interpreting the literature to identify gaps and propose new research avenues.

The study began with a thorough definition of the research protocol, including the identification of relevant research questions and a comprehensive keyword selection process. This step involved preliminary searches and discussions among the authors to refine the search terms and ensure exhaustive coverage of the topic.

Accordingly, 1,661 articles were collected from the Scopus database and, after a rigorous screening process, 78 articles were retrieved for detailed analysis. This process involved independent reviews by the authors and a final debate to mitigate biases and ensure consensus. Then, the authors utilized bibliometric and content analysis techniques to rationalise data and deliver findings, adhering to a rigorous four-step protocol for ensuring reliability and replicability.

1.2.2 Research paper 2: Multiple Case Study with Critical Realist Approach

The second research employs an inductive approach through a multiple case study design, grounded in a critical realist philosophical stance. Such a philosophical interpretation emphasizes the understanding of underlying mechanisms and causal relationships that drive circular product and process innovation. In line with these settings, the second study aims to empirically explore two collaborative circular business models and their mechanisms through which CE practices and processes are carried out. Relying on grounded theory, it showcases how inbound and outbound open innovation strategies take place in a circular supply chain and a circular ecosystem.

In sum, the study focused on two collaborative settings within the food and beverage industry, involving 13 organisations in total. The authors conducted in-depth individual and group interviews, complemented by secondary data from public reports and company websites. In line with a critical realist interpretation of the real world, the flexible interview protocol evolved throughout the study to capture the dynamic nature of the collaborations.

Data was analysed prioritising causal explanations and contextual understanding. The authors employed data triangulation and intercoder reliability checks to ensure the accuracy and validity of the findings. As a result, the empirical analysis unpacked the network of relationships and resource exchanges within collaborative settings, providing a detailed causal representation of the inter-organizational dynamics of companies seeking to translate CE principles into practice.

1.2.3 Research paper 3: Multiple Case Study with Positivistic Approach

The third study also undertakes inductive reasoning in the form of a multiple case study design, yet adopting positivistic philosophical reasoning. This methodology is suitable for exploring phenomena with limited prior theoretical understanding,

such as the role of digital technologies in SMEs' transition to CE. Thus, the third research paper is meant to build on previous findings from the systematic review to specifically explore digital technology implementation in companies.

The authors selected 16 SMEs from various industries in Italy, known for their operational agility and potential for CE engagement. Data were collected through semi-structured interviews with managers and employees, supplemented by company documents and secondary sources. As a result, this approach facilitated a comprehensive understanding of each case's circular practices.

According to the grounded theory approach, the data analysis was aimed at the development of new theoretical awareness from empirical observations. I performed a cross-case analysis relying on the Gioia methodology to develop first-order concepts and second-order themes, leading to new insights about the adoption of digital technologies in CE contexts. Ultimately, the positivistic lens ensured objective data collection and replicable findings, enhancing the study's reliability.

1.2.4 Research paper 4: Deductive Study based on Structural Equation Modeling

The fourth study utilizes a deductive approach to theory building by testing four hypotheses, elaborated on the CE and innovation management literature, by structural equation modelling technique. This methodology allows for the validation of theoretical constructs and the examination of relationships among green innovation, open innovation, and circular economy implementation in businesses. In sum, this paper is meant to bridge innovation management and CE discussing some unique resources and favourable conditions that trigger the circular transition in businesses.

The authors collected data from 318 managers of as many European for-profit companies through an online survey. In order to ensure reliable responses, the sample included managerial figures with at least one year of experience in their current positions. Furthermore, the questionnaire was designed to incorporate variables containing multiple items, so as to measure constructs related to green product and process innovation(independent variable), open innovation practices (moderator), and CE implementation (dependent variable).

Finally, the measurement model's validity and reliability were assessed by confirmatory factor analysis, and data was processed using covariance-based structural equation modelling. This method facilitated the testing of the conceptual model, corroborating the hypotheses by rigorous quantitative validation.

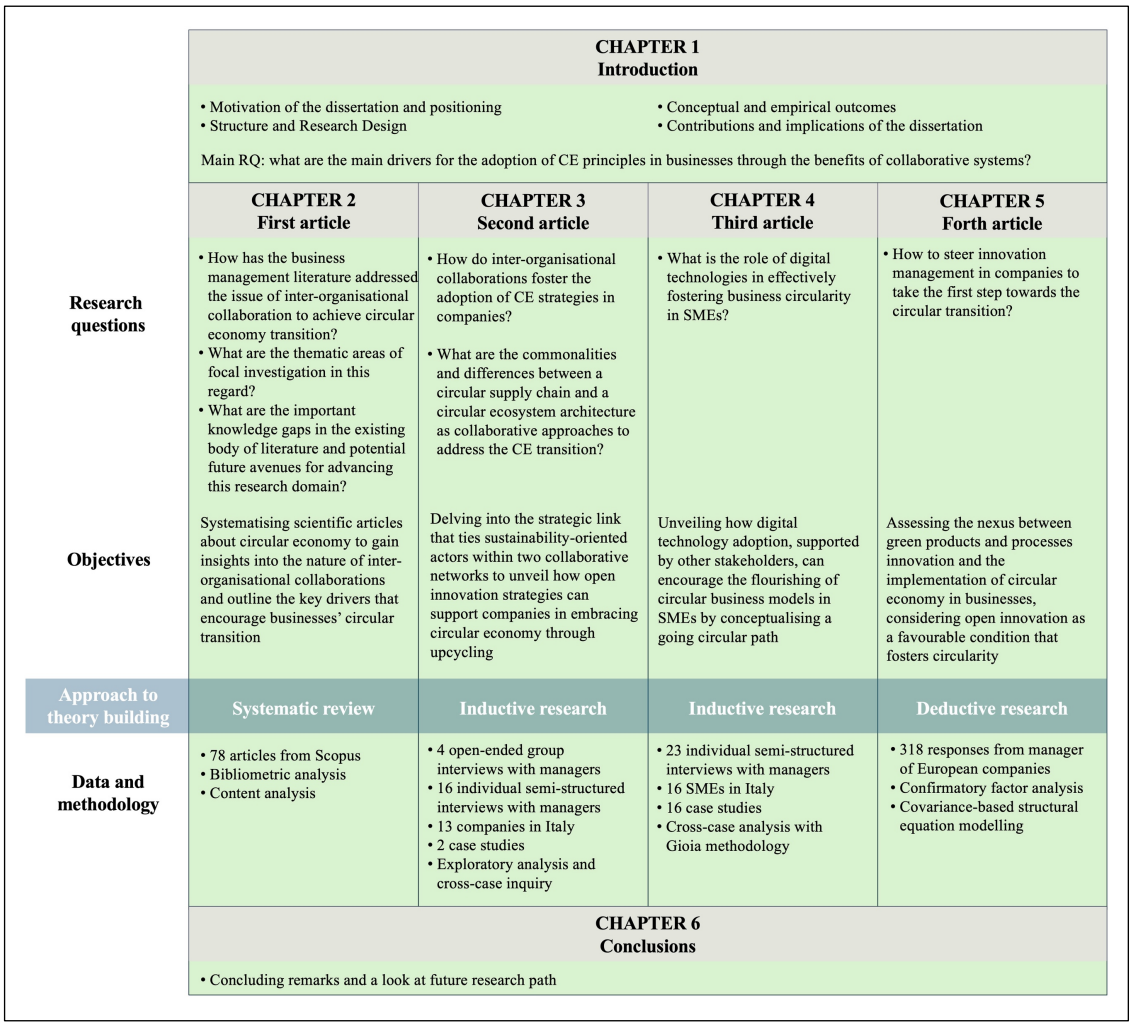
1.2.5 Wrap-up and graphical representation of the dissertation

Overall, the integration of these four studies forms a comprehensive research design that addresses the doctoral project's research questions from multiple angles. The systematic literature review establishes a solid theoretical foundation and identifies research gaps, some of which have been addressed in the subsequent studies. Hence, the second and third multiple case studies, characterised by their distinct philosophical approaches, offer deep insights into the practical implementation of CE principles thanks to open innovation strategies and digital technologies adoption. Finally, the deductive study quantitatively validates the theoretical constructs and relationships observed in the prior studies, ensuring a robust and holistic understanding of stakeholders' collaboration to improve innovation management strategies for embracing the CE transition.

As a result, the multi-method research design of the present dissertation not only provides a thorough exploration of the topic but also enhances the validity and reliability of the findings through methodological triangulation. By combining a systematic review with qualitative and quantitative empirical studies, the dissertation offers valuable contributions to both theory and practice. Its outcomes contribute to advancing scholars and practitioners' awareness about the main drivers that businesses should effectively leverage by taking advantage of strategic collaborations. In other words, this dissertation scientifically promotes awareness of how businesses can effectively collaborate and innovate collaborative circular business models to achieve a sustainable future.

Below, Figure 1 offers a graphical representation of the doctoral dissertation.

Figure 1. Structure of the doctoral dissertation



Source: Authors' elaboration

1.3 Discussion of the Conceptual and Empirical Outcomes

As the thesis is structured into four studies, the results obtained from each of them fall into an articulated research project. Therefore, the articles were mostly developed in parallel to take wise steps towards a research path aimed at shedding light on the main drivers that affect the adoption of CE principles in businesses through the benefits of inter-organisational collaboration.

As an initial work to familiarise myself with the main topic, I decided to carry out a systematic literature review to provide a comprehensive systematisation of the existing body of literature on CE from a meso-level perspective. It allowed the authors to map previous scientific contributions and recognise the most debated thematic areas. The first key outcome is represented by the identification of the fragmented nature of the existing literature on CE, which highlights the need for a structured approach to guide both academics and practitioners. The review

emphasizes that most of the current research is qualitative, focusing on exploratory studies, and reviews, with a notable lack of empirical investigations. This observation underscores the necessity for future studies to adopt quantitative methods, which could empirically assess and validate theories, thereby contributing to the development of robust measurement models and decision-support tools. As a result, the literature stream showed to be in an initial exploratory research phase, where it is necessary to study and recognise phenomena related to the application of CE principles in companies to, then, empirically validate the theoretical constructs identified.

Moreover, the bibliometric and content analyses provide a thorough understanding of three primary forms of inter-organizational collaborations, crucial for addressing the circular economy transition. Circular project-specific collaboration, circular supply chain, and circular ecosystem architecture are thus formalised and detailed in the systematic review. These collaborative approaches are categorized based on the different stakeholders involved, their relationships structure and the governance of the collaborative models, as well as considering their time horizon and scope.

Finally, another interesting outcome from the systematic review comes from the observation of cross-cutting factors common to each kind of collaborative structure. In this vein, five factors emerged as potential drivers for the CE transition, addressed in collaborative models. Open innovation, dynamic capabilities, digital technologies, stakeholders' engagement and interaction, value creation and distribution result as the main themes that demand further investigation in collaborative circular business models.

The second study builds upon the findings provided by the systematic literature review, advancing a comprehensive examination of the open innovation mechanisms of two specific collaborative approaches. In response to the gap found in the literature, the findings of this empirical paper inductively led to theory building by exploring and comparing a circular supply chain and a circular ecosystem.

As a result, the third qualitative research of the dissertation highlights the significant role of inbound and outbound innovation strategies in fostering the development of circular products, processes or practices. It provides empirical evidence that collaborative innovations are essential for overcoming the barriers

and technical challenges associated with circular products and processes, such as waste manipulation for recovery, design and implementation complexities, financial support, and market entrance. Overall, the authors' findings underscore the importance of strategic collaborations in acquiring critical resources and knowledge, which are indispensable for the successful implementation of sustainable practices.

In detail, the empirical investigation allowed us to unveil how circular supply chains involve industry-specific collaborations where companies leverage critical knowledge to utilize waste as a resource in premium circular product processing. This approach has been shown to effectively support open innovation strategies by integrating stakeholders within a specific industry to enhance resource utilization and reduce waste generation. On the other hand, the circular ecosystem approach involves more participatory and interactive collaborations across different sectors. This second approach necessitates greater orchestration efforts and a more structured scheme for value creation and distribution, leveraging the territorial proximity of actors to facilitate resource and knowledge exchange.

The role of central actors, identified as supply chain coordinator and ecosystem orchestrator, was also found to be crucial yet different in both collaborative approaches. In the circular supply chain, the coordinator facilitates interactions among stakeholders, optimizes material utilization, and streamlines processes to promote resource circularity. In contrast, the orchestrator in circular ecosystems was observed operating across industry boundaries, fostering collaboration among diverse stakeholders, ensuring fair resource distribution, and promoting equitable value sharing. Such findings also enrich the understanding of the diverse roles played by central actors in driving collaborative networks towards CE transition.

In summary, the findings of the third article advance delve into open innovation as a key driver to address the CE transition by advancing the very first scientific contribution that explored this phenomenon by comparing two collaborative patterns established for circular purposes.

Moving forward, the *third study* further complements the research path drawn by the systematic review. Delving into one of the drivers uncovered, it aims to explore the role of digital technologies in supporting the CE transition, specifically observing SMEs. Such a sample offered very inspiring cases of companies that

have harnessed digital technologies to tackle their circular transition, thanks to SMEs' propensity to collaborate and agility.

As a result, this study firstly identifies a four-stage model of circular business evolution named “Going Circular Path”, which includes four steps toward a higher circularity degree of businesses (i.e., idea generation, first steps, circular climbing, and circular maturity). After the conceptualisation of this model, the article suggests how digital technologies play a specific role in each stage, facilitating the translation of CE principles into feasible practices and accessing the scalability and efficiency of circular processes. According to each stage of the “Going Circular Path”, the study outlines four main roles of digital technologies – shaper, enabler, enhancer, and refiner – each supported by specific themes and concepts derived from case studies. During the idea generation phase, available digital technologies shape circular product and process development. For instance, businesses rely on the Internet of Things and artificial intelligence to inspire circular product design, or take into account take-back processes thanks to geolocation or RFID tags for material identification. Digital technologies also enable the establishment of circular practices and processes by facilitating stakeholder coordination and information flow. Companies showed how digital support is fundamental in enhancing existing circular processes during the circular climbing stage, for instance optimizing waste recovery and stakeholder engagement. Finally, in mature circular businesses, digital technologies refine processes to achieve higher efficiency and greater circularity degree, as evidenced by optimization efforts in production and resource exploitation. In sum, the final model provides a structured understanding of the best way to exploit product and process innovation with digital technologies, taking into account their different purposes according to the circular maturity of a business.

Rooted in the outcomes of the systematic literature review, as well as following the claims of the two previous empirical research, *the fourth study* provides a more comprehensive understanding of the nexus between innovation management and the implementation of CE in businesses. According to a deductive approach to theory building, it advances how companies inclined towards green innovation in product design, packaging, sourcing, operations, and logistics are more likely to engage in a circular transition. More specifically, this fourth research furthers the debate about innovation management dwelling on key resources and knowledge acquired while dealing with sustainable innovations. Companies that engaged in

this kind of innovation showed to be capable of better harnessing CE dogmas. As a result, our findings provide generalizable conclusions, demonstrating that businesses' experience with green innovation can enhance CE practices and processes.

In particular, we included the moderating effect of open innovation practices on the relationships between green innovation and CE implementation in businesses. The findings indicate that open innovation strategies – i.e., inside-out, outside-in, coupled – significantly support the integration of CE principles into business practices, granting the combination of critical knowledge or competencies developed in-house while approaching sustainable innovations with the pool of resources and know-how owned by external actors committed to the circular transition. As a result, this fourth study offers empirical validation of the relevance of strategic collaborations in developing circular-oriented innovations and, in particular, we offer evidence about how open innovation enhances the effectiveness of skill base, knowledge, and resources owned by a company in combination to the external ones owned by multiple stakeholders.

In conclusion, the *whole research project* has followed a comprehensive and systematic path to properly answer the main research question. At this point I can underscore several critical drivers that can support businesses' circular transition, especially considering inter-organisational collaboration. Firstly, collaboration with competitors, suppliers, retailers, clients, foundations, or public organisations emerges as a fundamental element in achieving the CE transition. The different collaborative approaches identified – circular project-specific collaboration, circular supply chains, and circular ecosystems – highlight the various ways in which businesses can work together to develop circular products and processes. Findings from this research project emphasize that inter-organisational collaboration allows businesses to leverage external resources and knowledge, which are essential for overcoming the barriers and challenges associated with circular innovations.

Secondly, where collaborating seems to be the right approach to deal with the circular transition, open innovation is the key to succeed in such an ambitious quest. Although it was discovered in the 1990s, this approach to innovation is now more prevalent than ever and, especially in the sphere of circular innovations, it has becomes a strategic imperative to achieve sustainable development. Furthermore, the role of innovation management and companies' winking at green

innovations proved critical in ensuring sustainability awareness to deal with CE. Companies that innovate in product design, packaging, sourcing, operations, and logistics are better prepared to translate CE principles into feasible and economically sustainable activities. In this vein, open innovation strategies can even amplify the effectiveness of companies that are familiar with sustainable innovations. As a consequence, we recommend companies to carefully handle innovation management by planning their moves in advance, and to engage in collaborations with other organisations.

Third, process and product innovation that takes advantage of digital technologies play a pivotal role in shaping, enabling, enhancing, and refining circular practices and processes. Digital technologies, as innovation tools, are indeed crucial at every stage of a circular business's evolution, from idea generation to circular maturity. Digital tools facilitate stakeholder interaction and collaboration, optimize resource and energy flows, and enhance the efficiency of circular processes. These findings highlight the need for businesses to strategically invest in digital technologies to support their CE initiatives.

In conclusion, the dissertation's outcome underscores the importance of collaboration, digital technologies, and sustainable innovation in achieving the CE transition. Future research should continue to build on these findings, providing further empirical evidence and practical insights to support businesses and policymakers in their efforts to promote sustainable development.

1.4 Theoretical Contributions of the Dissertation

As observed reding the scientific papers sampled while carrying out *the systematic literature review*, previous authors drew from several theories to study CE in business management, specifically looking at inter-organisational collaborations' dynamics. Among them, it is worth mentioning the resource-based view (Hansen & Revellio, 2020; Johnson, 2022; Mishra et al., 2021; Tseng et al., 2022), stakeholder theory (Eisenreich et al., 2021; Moggi & Dameri, 2021; Tapaninaho & Heikkinen, 2022), dynamic capabilities perspective (Santa-Maria et al., 2022; Sehnem et al., 2022b), social capital theory (Leder et al., 2020), system thinking (De Angelis et al., 2022), organisational sensemaking theory (Hussain & Malik, 2020), organisational learning and organisational change management theories (Tseng et al., 2022). The most frequently adopted theoretical lenses proved to be the first two, however. In order to understand the drivers that companies should

leverage in collaborative systems to encourage the CE transition, the resource-based theory supports the strategic importance of unique resources and capabilities (Barney, 1991; Wernerfelt, 1984), which are meant to be leveraged through collaboration to achieve competitive advantage and sustainable development (Barney, 2018; Freeman et al., 2021; Hart, 1995). On the other hand, the stakeholder theory highlights the underlying intention of addressing the interests and demands of various stakeholders, including partners, customers, and regulatory bodies, to foster sustainable and cooperative business practices in the circular economy transition (Freeman, 1984, 2010; Parmar et al., 2010).

In line with previous contributions, this research project mainly builds on the theoretical milestones offered by the resource-based view and stakeholder theory in the second and fourth studies. In addition, the third study introduces a less covered theory in this literary stream, namely the institutional theory (DiMaggio & Powell, 1983; Haunschild & Miner, 1997; Meyer & Rowan, 1977), to comprehend companies' isomorphism in adopting CE principles based on sociological and economic mechanisms.

Drawing on the resource-based view perspective (Barney, 1991; Grant, 1991), *the second research paper* illustrates how organizations leverage rare and valuable resources and critical knowledge to achieve circular-oriented innovations through two collaborative approaches. Complementing previous studies (e.g., Chaudhuri et al., 2022; Coppola et al., 2023; Hansen & Revellio, 2020; Johnson, 2022; Kusumowardani et al., 2022; Mishra et al., 2021; Muench et al., 2022; Sehnem et al., 2022a; Tseng et al., 2022), this one emphasizes the significance of both internal and external resource employment in circular business models, as well as the assimilation of diverse expertise across industries, as fundamental drivers in creating and sustaining competitive advantage within CE initiatives. In detail, it showcases the intricate interplay between resources and knowledge in collaborative networks, addressing barriers to the CE transition. In alignment with the resource-based theory, these collaborative endeavours highlight the importance of unique and non-substitutable resources such as specialized knowledge of waste treatment processes, technological capabilities for material recovery, and cross-industry expertise in driving circular-oriented innovations.

The integration of such critical resources and knowledge in collaborative circular business models can also be understood through the stakeholder theory, applied in the business ethics domain. In this vein, the second study aligns with the

fundamental tenets of stakeholder theory (Freeman, 1984; Freeman et al., 2010; Parmar et al., 2010) by illustrating the intricate relationships and interactions among various actors in both the circular supply chain and the circular ecosystem architecture. Such findings emphasize that the successful implementation of circular-oriented innovations is contingent upon acquiring critical resources and knowledge, as well as establishing robust inter-organisational relationships among stakeholders (Eisenreich et al., 2021; Gu et al., 2024; Moggi & Dameri, 2021; Tapaninaho & Heikkinen, 2022). The second study thus underlines how stakeholder relationships and inclusive collaboration serve as catalysts for achieving shared goals and value creation, enhancing our understanding of equitable value distribution and fair remuneration among stakeholders within the collaborative circular business model.

Overall, the second study brings together the resource-based view and the stakeholder theory to feed the literature at the intersection of CE and open innovation (Bocken & Ritala, 2021; Jesus & Jugend, 2023; Köhler et al., 2022; Suchek et al., 2021), specifically dwelling on circular-oriented innovation (Blomsma et al., 2019; Brown et al., 2019; Johnson, 2022). The exploratory multiple case study depicts how open innovation strategies substantiate collaborative circular business models, focusing on stakeholders' collaboration mechanisms and critical resources and knowledge exchange to co-develop circular-oriented innovations. Accordingly, it emphasizes the importance of cross-supply chain and cross-industry strategic alliances to leverage open innovation practices in the CE transition (Bertassini et al., 2021; Moggi & Dameri, 2021; Tapaninaho & Heikkinen, 2022; Zucchella & Previtali, 2019).

In line with the second study, *the fourth research paper* integrates the resource-based view framework with insights from the natural-resource-based view (Hart, 1995; Hart & Dowell, 2011) and the stakeholder-resource-based view (Barney, 2018; Freeman et al., 2021). It elucidates how firms leverage tangible and intangible resources, including environmental input and stakeholder relationships, to drive CE practices. This study bridges innovation management and CE literature by empirically examining the role of innovation, particularly green and open innovation, in facilitating the adoption of circular practices (Ai et al., 2024; Khan et al., 2023; Pichlak & Szromek, 2022). Responding to previous contributions that explored strategic collaborations aimed at promoting circular-oriented innovations (Bocken & Ritala, 2021; Brown et al., 2020; Jesus & Jugend, 2023; Kaipainen et

al., 2022; Perotti et al., 2024), this research provides generalisable conclusions by assessing the role of open innovation strategies in leveraging resources and knowledge acquired by engaging in green innovation to, finally, foster CE implementation in businesses.

By focusing on green innovation and openness in innovation processes, the fourth study expands the resource-based view theory within the context of circular businesses, recognising the clear influence of the stakeholder perspective. Through empirical validation, the findings demonstrate how properly handling innovation management means to recognise internal critical assets and leverage external relationships as a strength of the firm, which can effectively lead to drive circularity in businesses. Providing meaningful insights for academia and practitioners, this study contributes to explaining companies' successful adoption of circular practices, leveraging green innovation and openness in innovation processes as strategic approaches to gather critical resources.

In addition to these most common theoretical lenses that support CE research, the *third study* introduces a less covered theory in this literary stream, namely the institutional theory (DiMaggio & Powell, 1983; Haunschild & Miner, 1997; Meyer & Rowan, 1977). It delivers important considerations regarding how SMEs transition toward a renewable production and consumption paradigm thanks to the adoption of digital technologies (Khan et al., 2021; Kristoffersen et al., 2020; Liu et al., 2022). More specifically, the third study enriches the CE literature from the perspective of the extended institutional theory by depicting circular businesses' isomorphism and advancing the perspective of circular business models' legitimation of business digitalization. Contributing to previous studies that explored such a phenomenon through the institutional theory lenses (Do et al., 2022; Jain et al., 2020; Ranta et al., 2018), this study unveils SMEs' strategies for translating CE principles into circular processes and products, supported by digital technologies and Industry 4.0 structures developed with external stakeholders. It feeds the CE literature by advancing a "going circular path" that outlines four evolutionary stages of circularity in businesses, unveiling four needs fulfilled by as many digital technologies functions. As a result, the research draws on the isomorphic behaviour of companies to promote circular businesses' digitalisation awareness by associating specific functions of digital tools with each step of the "going circular path".

In conclusion, this research project went through different theoretical standpoints to enrich the CE literature. Dwelling on the main drivers that trigger or support the adoption of circular principles in businesses, this dissertation contributes to the understanding of the main drivers that businesses embedded in collaborative systems can leverage to achieve sustainable development. It offers new insights into collaborative circular business models, strategic alliances, open innovation strategies, and digital tools in driving circular-oriented innovations, providing a comprehensive overview to nurture future research and support companies in practice.

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CHAPTER TWO

Unravelling Inter-organisational Collaborations to Address the Circular Economy Transitions: A Systematic Review[1]

Abstract

This study offers a systematic review of the growing body of literature about circular economy. Circular business model's successful implementation is highly reliant on stakeholders' interactions in collaborative patterns, as they bring together specific knowledge and resources to cope with barriers to circular practices development. In response to lack of general conceptualization and characterisation of collaborative approaches, this article provides a clearer picture of sustainable-oriented collaboration strategies described in the circular economy literature. The research design is based on bibliometric and content analysis of 78 articles and our findings unveil three thematic clusters with the intention of putting forward a novel conceptual compass to shed light on collaborative circular business models. Delving into circular networks and stakeholders' collaboration, we provide a practical support for decision-making to achieve sustainable development through circular economy. As a result, we suggest some future avenues by handing some research questions for forthcoming studies.

Keywords: *circular economy, collaborative circular business models, partnership, supply chain, ecosystem, network*

2.1 Introduction

In light of looming environmental challenges and the compelling pressure on global resources, the take-make-use-dispose production systems proved to be no longer sustainable (European Commission, 2020; United Nations, 2021). Whereas there is a critical need for sustainable solutions that can underpin a balanced economic model, the concept of a circular economy (CE) offers a holistic, transformative, and restorative approach to achieve sustainable development (Hina et al., 2023; Murray et al., 2017). It is based on the awareness of planetary resources limits, as well as the vision of a world like a system in which different

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actors collaborate to reduce pollution and waste, by maximizing ecosystem functioning and human well-being in a "cradle-to-cradle" economy (Brown et al., 2021b; Kanda et al., 2021; McDonough & Braungart, 2010). Aware, more and more organizations are expressing a deep commitment to CE principles implementation through the adoption of innovative processes and tools (Bocken et al., 2016; Bressanelli et al., 2022; Ranta et al., 2018; Sohal & De Vass, 2022), which means translating sustainable purposes into business practices by giving rise to circular business models (CBMs) (Centobelli et al., 2020; Geissdoerfer et al., 2020; Hopkinson et al., 2018).

The approach to sustainability offered by CE concerns the development of innovative business models that incorporate established CE principles in dynamics of value proposition, value capture, value creation and delivery (Bocken et al., 2016; Ferasso et al., 2020). As such, business models' innovation to implement CE principles has been recognized as essential to move organizations from a linear to a circular approach, which is capable of meeting people's needs while respecting social and environmental, as well as economic, sustainability (Lüdeke-Freund et al., 2019; Pieroni et al., 2019; Ranta et al., 2018). Economic organizations are thus called to evolve the way of doing business, and reorganising in systemic configurations that connect actors' innovation activity represents a validated strategic approach to address the CE transition (Hopkinson et al., 2018; Kanda et al., 2021; Köhler et al., 2022; Perotti et al., 2024). In this vein, numerous academics have highlighted how the circular transition may require more than just single business focused transformations (Ciulli et al., 2020; Konietzko et al., 2020; Moggi & Dameri, 2021; Zaoual & Lecocq, 2018). The effort required to implement CE logics in traditional (or new) businesses usually requires knowledge and resources that go far beyond the normal availability of individual companies, so it happens to end up being faced with a dilemma: either give up or open up?

In line with the meso-level comprehension of the CE (Barreiro-Gen & Lozano, 2020; Bressanelli et al., 2022; Ghisellini et al., 2016; Murray et al., 2017), inter-organisational collaboration has been discussed as viable approach to establish renewable production systems (Moggi & Dameri, 2021; Perotti et al., 2024; Tapaninaho, R., & Heikkinen, 2022; Zucchella & Previtali 2019). For instance, the CE literature introduced collaborative circular innovations, circular supply chains, circular ecosystem architectures, industrial symbiosis, circular districts as formations that leverage collaborative environments and inter-organisational

exchanges. Accordingly, the systematic review of the literature on CE and innovation advanced by Suchek et al. (2021) recognised strategic alliances as a thematic area that deserves further exploration. It is therefore necessary to dwell on the interactions and synergies between different stakeholders, linking departments, functions, and individuals to develop cooperative sustainable innovations (Brown et al., 2019; De Angelis et al., 2023). Prior studies such as Köhler et al. (2021) or Jesus and Jugen (2023) also emphasised the close link between circular economy and open innovation mechanisms. In sum, inter-organisational collaboration facilitates the integration of circular principles and practices across different organizations, leveraging external critical resources, knowledge and capabilities to overcome barriers towards sustainable development (Aarikka-Stenroos et al., 2022; Galvão et al., 2022; Seles et al., 2022; Wade et al., 2022). Past research such as Dangelico and Pontrandolfo (2015) or Yu et al. (2022) have even emphasised how the collaborative strategies of circular businesses can represent the nexus between environmental management and firm performance. As a result, academics and practitioners have acknowledged the importance of inter-organisational collaboration in achieving circularity (e.g. Aarikka-Stenroos et al., 2022; De Angelis, 2022; Jesus & Jugend, 2023; Tapaninaho & Heikkinen, 2021; Zucchella & Previtali, 2017), albeit it still represents a shadowed topic which demand for a specialised inquiry. Despite the attempt of previous reviews in the CE domain (see Table 1), the scientific debate is rather murky as for legitimised inter-organisational collaborative approaches and stakeholders' nature yet (Cooper & Claxton, 2022; Pedersen et al., 2022; Tapaninaho & Heikkinen, 2022). Even though previous reviews attempted to explore the meso dimension of CE related to inter-organisational collaboration (e.g., Suchek et al., 2021; Jesus & Jugend, 2023; Sudusinghe & Seuring, 2022) and circular supply chain management (e.g., Eisenreich et al., 2022; Lahane et al., 2020; De Angelis et al., 2018), extant research falls short in terms of clarifying the specific types, characteristics, and influencing elements of collaborative circular business models that can effectively drive the circular transition.

Table 1. Most relevant systematic literature reviews in the circular economy domain

Article information	Research questions / Objectives	Outcomes and implications	Level of analysis	Review method	Range of years
Jesus and Jugend (2023) *How can open innovation contribute to circular economy adoption? Insights from a literature review*	- How can open innovation contribute to the adoption of CE?	The authors encourage collaboration practices among partners and the adoption of co-creation approaches, to leverage on open innovation through partnership networks between private and public institutions and local communities.	Meso level	Bibliometric and content analysis	2016-2021
Eisenreich, Füller, Stuchtey, and Gimenez-Jimenez (2022) *Toward a circular value chain: Impact of the circular economy on a company's value chain processes*	- Which implications does the introduction of circular solutions have for a company's value chain processes?	Value chains need to be adjusted for addressing CE considering how a) the linear production should be rethought to include multiple product life cycles, and b) the classic framework advanced by porter does not sufficiently emphasise connections between value chain categories nor acknowledges their interrelations with external stakeholders.	Firm level	Descriptive and content analysis	1990-2020
Sehnem, de Queiroz, Pereira, dos Santos Correia, and Kuzma (2022) *Circular economy and innovation: a look from the perspective of organizational capabilities*	- What is the profile of publications dealing with CE and innovation? - How do researchers explore the existing interface between the concepts of CE and innovation? - What is the role of innovation in the transition to circular production models?	This study showcase how CE and innovation are related in the organisational context, outlining practices, organisational capabilities, types of innovation and management options adopted to implement CE in companies.	Firm level	Descriptive and content analysis	2016-2020
Sudusinghe and Seuring (2022) *Supply chain collaboration and sustainability performance in circular economy: a systematic literature review*	- What are the different collaboration practices leading to improved sustainability performance in CSCs? - What are the managerial and theoretical implications to ensure the implementation of circular supply chains through collaboration?	This study presents a framework for achieving sustainability performance through supply chain collaboration, highlighting how collaboration needs to be evolved in supply chains. Furthermore, it outlines why the upstream and downstream perspectives on collaboration, as well as supply chain collaboration practices, need to be changed to address the CE transition.	Meso level	Descriptive and content analysis	2016-2020

Suchek, Fernandes, Kraus, Filser, and Sjögrén (2021) *Innovation and the circular economy: a systematic literature review*	The paper aims to provide insights into how innovation can drive the transition towards CE, outlining different research themes and emphasizing the importance of cooperation and collaboration by highlighting internal and external factor to consider while addressing the CE transition.	Innovation in the CE depends on forming strategic alliances and taking a multi-level approach incorporating all interested parties. These alliances enable the sharing of knowledge, raw materials, technology, and information crucial for companies to establish the conditions to capture the opportunities and develop innovation within the scope of the CE.	Firm and meso level	Bibliographic and content analysis	2016-2020
Lahane, Kant, and Shankar (2020) *Circular supply chain management: a state-of-art review and future opportunities*	The study highlights the research trends, gaps, and set up future research directions in circular supply chain management literature.	The study recognized the importance of circular supply chain management in addressing the CE transition and identifies potential areas for future research directions in this domain.	Firm and meso level	Descriptive and categorical analysis	2010-2019
Centobelli, Cerchione, Chiaroni, Del Vecchio, and Urbinati (2020) *Designing business models in circular economy: a systematic literature review and research agenda*	The study pursues to examine the current understanding related to designing business models within the context of a circular economy transition, in order to develop a research agenda that guides studies.	Through the identification of four main topic areas related to the design of circular business models, the study put emphasis on the role of policy makers and government agencies in promoting circular economy transitions, as well as the importance of leveraging technological, socio-cultural, economic, and institutional features to achieve successful circular economy transitions.	Firm level	Descriptive and content analysis	2013-2018
Farooque, Zhang, Thurer, Qu, and Huisingh (2019) *Industry 4.0 technologies as enablers of collaboration in circular supply chains: a systematic literature review*	The study pursue to advance a new definition of circular supply chain management, map the related literature, and identify potential future avenues.	The article offers an integrated view of circular supply chain management and deliver suggestions for future studies in terms of design for circularity, procurement and circular supply chain management, biodegradable packaging, supply chain collaboration and coordination, circular consumption, product liability and producers' responsibility, technologies adoption, drivers and barriers to circular supply chain development.	Firm level	Content analysis	2006-2018

De Angelis, Howard, and Miemczyk (2018) *Supply chain management and the circular economy: towards the circular supply chain*	What are the implications for supply chain management in circular supply chains?	This study delivers insights about the potential element related to CE that cocnour to redefine supply chain management. It distinguishes traditional, linear, and circular supply chains and delivers a framework that supports yield insights into the CE and supply chain management.	Firm and meso level	Content analysis	2001-2017

Source: Authors' elaboration.

Given the broad spectrum of available literature, which is constantly and consistently growing, a systematisation of the scientific contributions on collaborative approach adopted by companies in pursuing CE is essential to shed light on businesses partnerships, supply chain alliances, industrial symbiosis, and ecosystems formation. As such, this research paper aims to address the outlined research gap conducting a painstaking systematic literature review (e.g. Ferasso et al., 2020; Hassan et al., 2023; Khan et al., 2021b; Madanaguli et al., 2021). The following research questions (RQs) have been raised accordingly, as compass for the academic contributions' selection within the wide literary landscape of the CE in business management (Kraus et al., 2020; Paul et al., 2021).

RQ1: How has the business management literature addressed the issue of inter-organisational collaboration to achieve circular economy transition?

RQ2: What are the thematic areas of focal investigation in this regard?

RQ3: What are the important knowledge gaps in the existing body of literature and potential future avenues for advancing this research domain?

In response to the lack of a holistic overview of prior findings besides the seek for a detailed research agenda, this study pursues to review and synthesize previous scientific articles to gain insights into the nature and impact of inter-organisational collaborations in the context of the CE. By employing a bibliometric analysis, elaborated with Biblioshiny and VOSviewer, the authors answer the first RQ by offering a detailed research profile and identify the main literature streams pertaining to the meso-level of CE comprehension. In response to the second RQ, a content analysis carefully outlines various collaborative patterns retrieved from previous studies. Finally, the third RQ is addressed by comprehensive discussion that builds on the results from the systematic review to recognise gaps and future avenues in this field.

In sum, the implications of this systematic literature review represent a valuable support to academics and practitioners in recognising and discerning different forms of collaborative circular business models to foster the CE transition. The present study makes two main contributions to CE literature. First, it strengthens the understanding of collaborative initiatives of sustainability-oriented organisations thanks to the characterisation of project-specific partnerships, circular supply chains, and circular ecosystem architectures (Brown et al., 2020; Kanda et al., 2021; Mishra et al., 2019). Secondly, it further the conceptualization

of collaborative circular business models and advance stakeholders'a nature, open innovation, dynamic capabilities, and digital technologies as a critical success factor in developing circular product and processes (Bocken et al., 2021; Brown et al., 2021b; Chesbrough & Appleyard, 2007; Enkel et al., 2009). As for managerial implications, this study offers a valuable strategic approach to companies aspiring to undertake a CE path. Respectively, we outline the common traits of each approach to open innovation in CBMs, providing a guide for managers to address the path that best suits each business. From the discussion of our analysis on CBMs literature, we intend to emphasise the relevance of collaborating with homogeneous and heterogeneous actors to amplify the scope of circular oriented innovations. Last but not least, promoting the awareness and adoption of renewable production and consumption systems, such studies are instrumental to the replacement of the natural earth's resources with positive repercussions for society and the well-being of humanity.

2.2 Conceptualising circular economy from a meso level perspective

In this systematic review of the literature, the authors delve into the concept of CE and its implications for businesses. Considering the focus of the research in the collaborations and alliances of sustainable-oriented companies, as strategic solutions for the implementation of renewable production and consumption systems, a premise on the scope of the research is in order.

The circular transition can be understood and approached in practice on three different levels, namely according to the dimension of analysis of the phenomenon CE (Barreiro-Gen & Lozano, 2020; Bressanelli et al., 2022; Ghisellini et al., 2016; Rovanto & Bask, 202). At the micro level, the literature is dwelling around CE adoption by the single firm and how companies can carry out different strategies to improve their circularity. Narrowing, slowing and closing strategies are analysed in the business dimension, besides CE practices such as refuse, rethink, reduce (for smarter product use and manufacture), reuse, repair, refurbish, remanufacture, repurpose (for extending lifespan of products and its components) recycle, and recover (for useful application of materials) (e.g. Bocken et al., 2016; Geissdoerfer et al., 2018; Hopkinson et al., 2018; Kirchherr et al., 2017). Broadening the investigation area of the issue to a meso perspective, it is possible to observe CE in terms of organisational interactions among various entities and economic realities by focusing on network strategies to approach the CE transition. In this

dimension, the stakeholder relationship perspective is more emphasised while studying circular businesses, where more interest is raised respect to companies' aggregation in industrial symbiosis and districts, partnerships, alliances along the supply chain, and ecosystems architectures (e.g., Aarikka-Stenroos et al., 2022; Baldassarre et al., 2019; Bressanelli et al., 2019; Farooque et al., 2019; Nogueira et al., 2023; Tapaninaho & Heikkinen, 2022; Zucchella & Previtali, 2017). Finally, CE on a macro level perspective can be acknowledged through the observation of social and infrastructure systems in delivering sustainable development pursuing a renewable production and consumption arrangement. For instance, previous studies observed CE from a macro perspective addressing urban ecology and eco-cities, zero-waste programs and innovative waste management, or collaborative consumption models based on shared ownership (e.g. Camacho-Otero et al., 2018; Leipold, 2021; Ness, 2008; Petit-Boix & Leipold, 2018). In general, these three lenses of interpretation of the CE have raised uneven interest among academics, economic organizations, and public entities (Barreiro-Gen & Lozano, 2020; Bressanelli et al., 2022; Ghisellini et al., 2016). The meso dimension, in particular, presents a considerable amount of research, although a comprehensive overview of the collaborative approaches of enterprises with respect to the construction of circular networks is inadequate (Bressanelli et al., 2022; Rovanto & Bask, 2021). The literature lacks a general conceptualization and distinction in approaches in this regard, where different collaborative architectures are described in an overlapping or obfuscated manner.

Therefore, the present study pursues to explore the CE literature segment that address interorganisational collaboration among circular businesses for the following reasons. Considering the role of collaborative approaches in promoting business' transition toward a renewable production and consumption system, first, openness strategic can offer a valuable approach to deal with sustainable development (Camilleri et al., 2023; Galvão et al., 2022). Secondly, the topic of collaborations and partnership to achieve sustainable development is rather wide and complex, since its roots can be traced back to different theoretical branch (i.e. innovation management, business ecosystem, and supply chain management). A literature review therefore serves to shed light on the different known approaches and to compare the various collaborative strategies with respect to their theoretical source. Overall, it is crucial to unravel collaborative approach to provide both academics and practitioners a clear guide through different collaborative approach.

A better understanding of these, broadens the scope for companies to adopt circular practices and, in particular, encourages the adoption of circular business models by leveraging collaborative approaches to break down barriers to the circular transition.

2.3 Methodology

Systematic literature review is a methodology that allows existing studies to be rationalised and interpreted, in order to offer an original point of view intended for stimulating new questions (Massaro et al., 2016; Kraus et al., 2020; Siddaway et al., 2019). Accordingly, the present study pursues to answer the advanced research questions by means of a comprehensive and critical review of the CE literature focused on inter-organisational collaboration. The authors employed bibliometric and content analysis techniques to outline the main features of this literary segment and address thematic clustering (e.g. Bargoni et al., 2023; Bretas & Alon., 2021; Vrontis & Christofi, 2021). First, bibliographic coupling was employed to identify emergent research trends and question past literature streams (e.g. Raut et al., 2023; Suchek et al., 2021). Then, a content analysis was conducted for summarising the knowledge available in the literature stream and shed light on each cluster to advance promising avenues for future research. In the intention of ensuring research reliability and replicability, this study echoes the four-step protocol legitimized by previous systematic reviews (e.g. Hina et al., 2023; Hassan et al., 2023; Khan et al., 2021a,b) that includes: planning the review, articles' screening criteria setting out, data extraction, data execution and research profiling. Overall, the data identification, screening, and selection process is outlined in Figure 2.

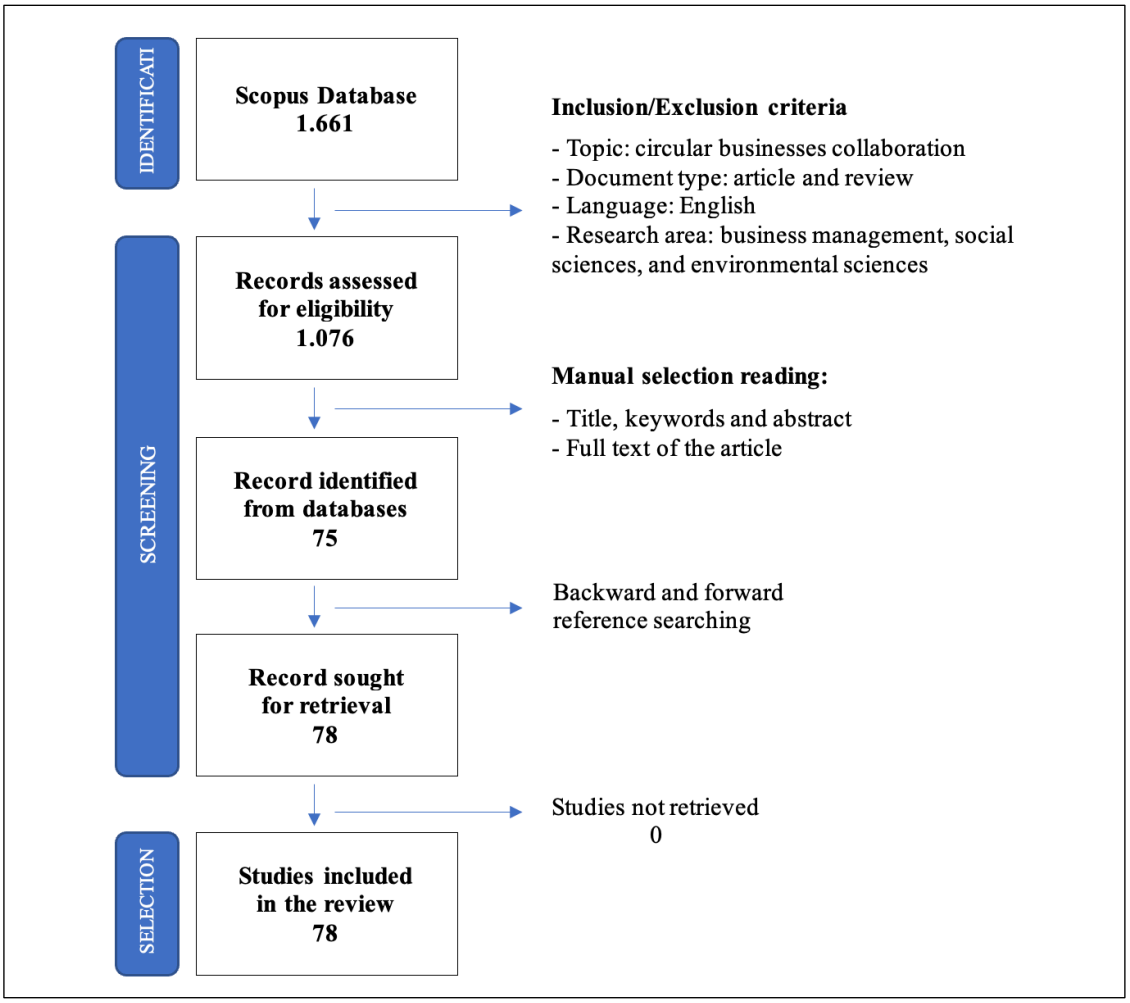
2.3.1 Planning the review

The first step towards conducting a systematic literature review is the definition of the research protocol. Assessing what is known about a defined topic, alongside the need for a systematic review, it is possible to identify a gap in the literature that leads to the development of some research questions (see the "1. Introduction" section). The study is meant to answer these interrogatives by means of a methodical review of the CE literature, which need to be focused on this precise domain through an accurate keyword selection. While a preliminary search on Google Scholar allowed us to test some first combinations of keywords, the main academic journals dealing with these topics have been reviewed lately to refine our

selection and assess keyword exhaustivity. Thus, the words combination derives from a thorough process of analysing the CE literature and subsequent discussion among the authors. In the attempt to collect as many studies as possible, which are closely related to the topic of inter-organisational collaborations in circular business models, the authors developed the search string showcased in Figure 3.

The final search string has been employed on a scientific repository to collect data for the review process. Scopus and Web of Science databases have been commonly used in systematic reviews of the literature, yet the authors favoured the first one according to previous studies that testify how Scopus has wide coverage in the social sciences' domain (Bargoni et al., 2023; Mongeon & Paul-Hus, 2016; Singh et al., 2021).

Figure 2. Literature search strategy



Source: Authors' elaboration.

Figure 3. Search string keywords

"innovat*" OR "collaborat*" OR "network*" OR
"open*" OR "r&d" OR "system*" OR "ecosystem*"

AND

"circular economy" OR "ce" OR "bio-economy*" OR "bio economy*" OR "circular*"

AND

"business model*"

Source: Authors' elaboration.

2.3.2 Screening criteria

Once the search string and database for data collection have been defined, the authors assessed the screening criteria of the literature review (e.g. Hina et al., 2023; Khan et al., 2021a,b). The inclusion criteria required data to meet three requirements: (a) studies dwelling on inter-organisational collaboration of circular businesses; (b) peer-reviewed articles in press or published by highly ranked scientific journals; (c) manuscript written in English language. On the other hand, some exclusion criteria have also been set out to discard: (a) research not strictly related to the CE domain CBMs; (b) articles not pertaining to business management, social sciences, and environmental sciences subject areas; (c) articles and informative resources categorised as grey literature, thesis papers, editorials, book chapters, and conference proceedings. As the first review pursuing to systematise CE literature from a meso perspective, the authors decided not to narrow the data collection to a specific time frame so as to consider all the studies available. Overall, these screening criteria allowed the authors to address the review with a reliable sources of information, following a transparent and globally replicable analysis of the literature (Kraus et al., 2020; Massaro et a., 2016; Tranfield et al., 2003).

2.3.3 Data extraction

The search string has been executed on the Scopus database covering papers' title, abstract and keywords, on January 2024. A total of 1.661 elements are identified in the database search. Then, the results were filtered according to the outlined

inclusion and exclusion criteria, so as to obtain 1.076 papers eligible for manual screening. The authors individually proceeded to select the articles in two steps process. An early screening took into consideration the main element of each record, namely article's title, keywords and abstract. In the second phase of the manual selection, the authors went through the full text of the remaining articles to define a narrowed final selection. With the intention of avoiding biases during data selection, the researchers independently undergone the two-step manual screening and shared their findings at the end of the process. Any discrepancies in paper selection have been solved by an extensive discussion to ultimately reach a consensus on the screening results. Finally, agreement was found on deeming 974 records inconsistent with the conceptual boundaries of the study, which were subsequently removed. As a result, 75 scientific articles was selected for being reviewed. While reading the articles, a citation chaining search was further performed to identify any further element not considered in the initial search. Based on their contributions in the CE literature, 4 additional articles were included in the final selection after a forward and backward reference searching, upon consensus of all the authors. Hence, the final number of articles covered by the review is 78.

2.3.4 Data execution and research profiling

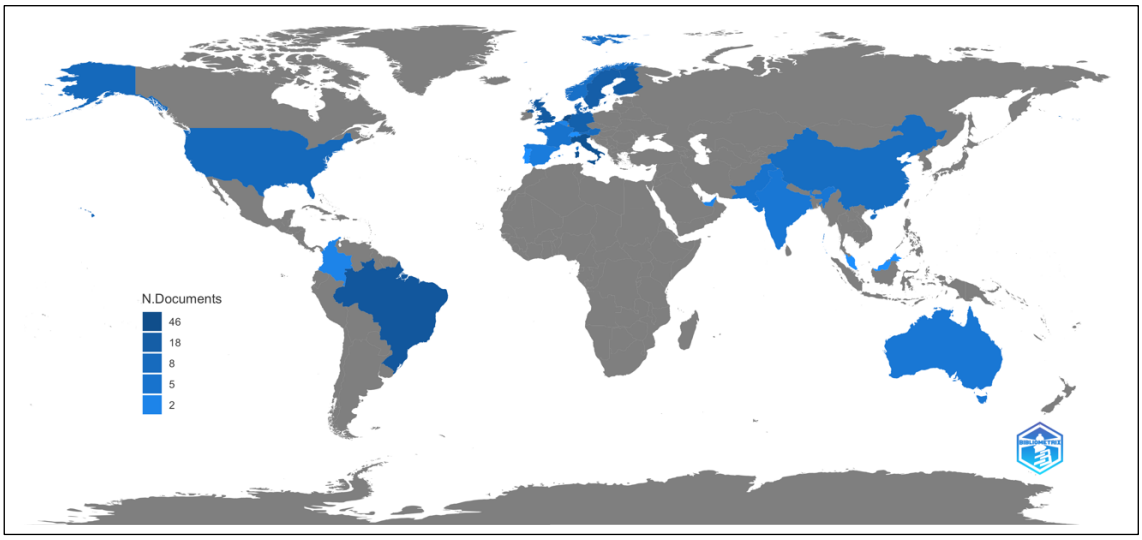
The selected papers were processed for the bibliometric and content analysis to explore the CE literature stream, recognise gap in previous studies, and outline future avenues. Table 2 resumes the main information of the dataset, obtained using the Biblioshiny software tool (Aria & Cuccurullo, 2017). Considering our final selection of 78 documents (67 research papers and 11 reviews), we can notice a growing tendency of the annual growth rate of the scientific production (44,22%) besides a great number of authors involved in the specific stream of inter-organisational collaboration in the CE literature domain. Moreover, Figure 4 showcases that the scientific production is concentrated in developed nations and some emerging countries, as well.

Table 2. Main information of the dataset

Description	Result
Timespan	2017 – 2023
Sources	23
Documents	78
Annual Growth Rate	44,22%
Average citation per document	75
References	6.291
Authors	219

Source: Authors' elaboration using Biblioshiny package in R.

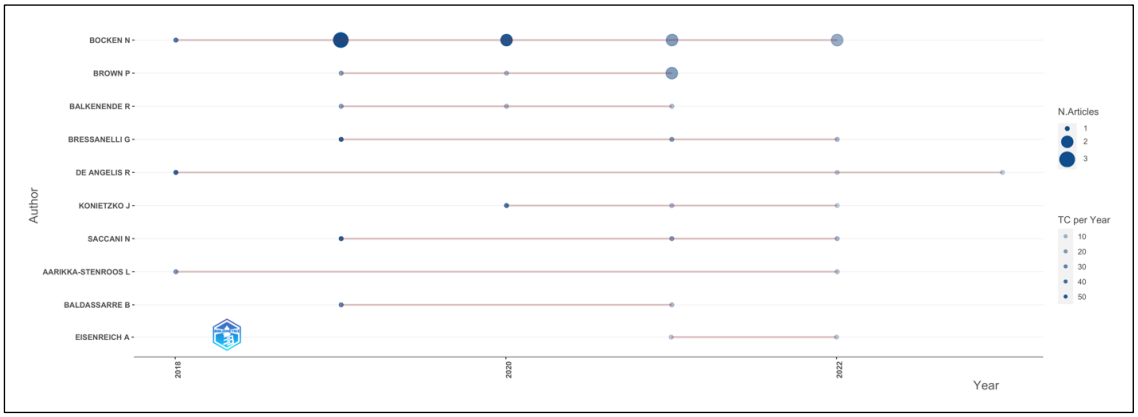
Figure 4. Scientific production by country



Source: Authors' elaboration using Biblioshiny package in R.

Considering authors' production over time (Figure 5), a greater concentration of work can be seen between 2019 and 2022, while the authors who have contributed most to the literature with impactful scientific articles are Nancy Bocken, Phil Brown, Ruud Balkenende, Gianmarco Bressanelli, Roberta De Angelis, Jan Konietzko, Leena Aarikka-Stenroos, Brian Baldassarre, and Anja Eisenreich. On the other hand, among the most frequent journals where the reviewed studies have been published, we can mention the Journal of Cleaner Production; Business Strategy and the Environment; Resources, Conservation and Recycling; Sustainable Production and Consumption; International Journal of Production Economics; Journal of Business Research; International Journal of Production Research; and Journal of Industrial Ecology.

Figure 5. Scientific production over time by author

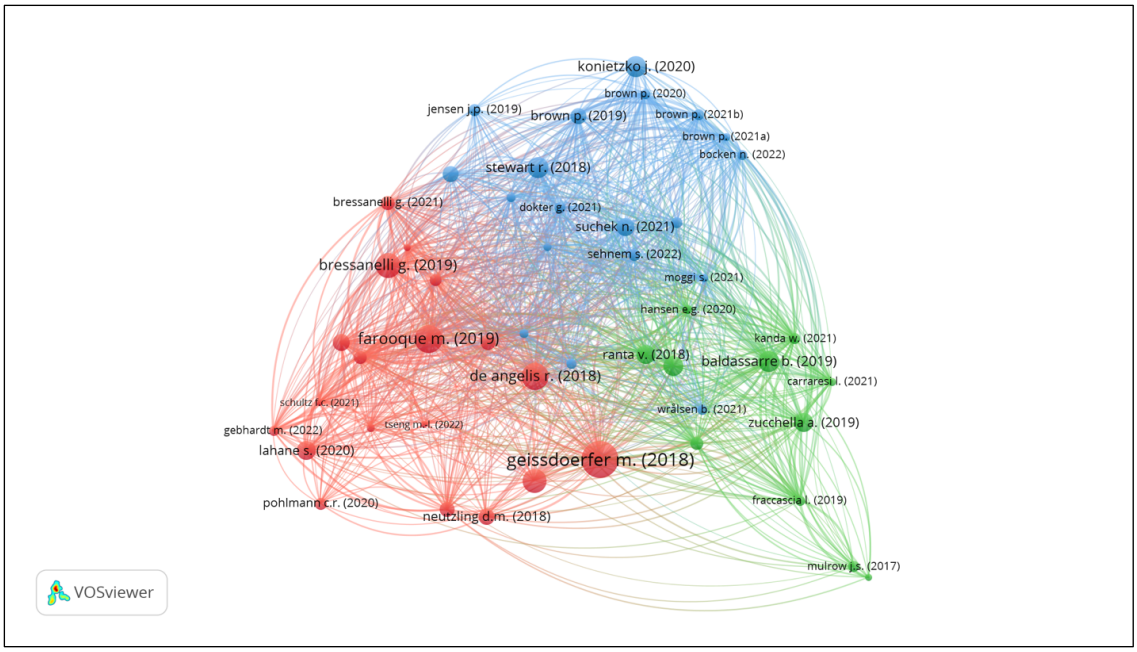


Source: Authors' elaboration using Biblioshiny package in R.

Observing the research profile of the sampled articles, most of the studies adopted a qualitative methodology to explore different collaboration strategies among companies and other entities through an inductive reasoning. The authors advanced multiple and single case study analysis, explorative research based on focus group interviews, and data analysis based on the fuzzy delphi methodology. This literature stream includes also some systematic review based on the topics of innovation, supply chain management, and collaboration enablers in the circular economy domain. Finally, a couple of papers addressed the topic from a deductive reasoning perspective to theoretical development employing a structural equation modelling technique. The reviewed papers also followed different lines in terms of theoretical positioning, where the most recurrent theoretical underpinnings showed to be the resource-based view, the dynamic capabilities perspective, the social capital theory, the stakeholder theory, the system thinking standpoint, the organisational learning theory, the organisational change theory, and the organisational sensemaking theory.

In conclusion, we used the VOSviewer platform to carry out bibliographic coupling to assess the relationships between the reviewed scientific publications based on their shared references (Figure 6). As a result, we can outline three different clusters where the studies generally dwell on innovation management in circular businesses collaboration (blue), the supply chain management redefinition according to the CE principles (red), the ecosystem setting and industrial symbiosis adopted by companies to address the CE transition (green). Based on the three literature roots identified with bibliographic coupling, the authors got support to advance the investigation of the thematic areas in this regard. Therefore, the next section offers the result of the content analysis elaborated on the sampled articles.

Figure 6. Bibliographic coupling analysis



Source: Authors' elaboration using VOSviewer.

2.4 Findings from the content analysis

2.4.1 Synthesis of the reviewed literature and clustering

To set the scene for the presentation of the thematic analysis' results and the following discussion, a premise is in order. The comprehensive analysis of the literature performed in this research emphasized the importance of inter-organizational collaboration while pursuing CE principles. Certain activities related to narrowing, slowing, and closing strategies demand for a collective approach, indeed value creation, capture, and delivery processes typically depend on an extended network of partners, suppliers, service providers, pubic institutions, or customers. The understanding of the intertwined network of activities behind the development of a circular business model is essential for acknowledging circular transition in firms (Bressanelli et al., 2022; Dangelico & Pontrandolfo, 2015; Hina et al., 2023; Geissdoerfer et al., 2020; Kanda et al., 2021). A multi-stakeholder approach to CE, allows technically highly demanding circular oriented innovations to be realised, as well as greatly enhancing their fields of applicability and impact to society and environment (Bressanelli et al., 2022; Boldrini & Antheaume, 2021; Pavan et al., 2021). As a result of our content analysis, it was possible to identify some common features and to classify the collaborative approaches adopted by companies into some well-defined clusters. Thus, the

authors advance a precise distinction among circular project-specific collaborations, circular supply chains, and circular ecosystems architectures. The remainder of this section is consequently intended to offer a thorough presentation of these strategic collaborative approaches, outlining their theoretical foundations and features that characterises each approach to the CE transition.

2.4.2 Circular project-specific collaboration

When it comes to project-specific partnerships thought to pursue CE principles implementation, it is essential to draw on literature dogmas on collaborative innovation management and the concept of sustainability, according to the triple bottom line (Brown et al., 2019; Elkington, 1994; Suchek et al., 2021; Hidalgo & Albors, 2008). In general, collaborative innovation has been raised by companies as a response to complex problems or opportunities in the form of collective intelligence and shared resources to pursue more effective and holistic solutions than any single entity acting alone (Brown et al., 2021b; Bryson et al., 2015; Wood & Gray, 1991). This concept finds more concrete formalisation in open innovation strategies, emphasising the value of external knowledge sourcing, cross-industry partnerships based on resources exchange, and value co-creation with external stakeholders (Chesbrough & Appleyard, 2007; Enkel et al., 2009). On the other hand, circular project-specific collaborations are based on sustainable purposes. While pursuing R&D efforts that reconcile economic, social, and environmental goals, previous studies have labelled this specific kind of output as sustainable innovations (Boons & Lüdeke-Freund, 2013; Cillo et al., 2019; Seebode et al., 2012). Then, specifically considering an approach where businesses and organizations actively collaborate with external stakeholders to co-create or develop innovations that promote sustainability, previous studies also referred to "sustainable open innovations" (Bogers et al., 2020, p. 1505; Kennedy et al., 2017). From these literature background, pursuing "circular oriented innovation" has been introduced as a specific approach to business sustainability that involves "the coordinated activities that integrate CE goals, principles, and recovery strategies into technical and market-based innovations" (Brown et al., 2019, p.3). In other words, circular oriented innovations can be referred as an attempt to innovate products, processes, organisational practices, and markets with the intent of slowing, narrowing and closing (material and energy) resource loops (Brown et al., 2020; Pieroni et al., 2019). As highlighted by Johnson (2022, p. 132), such term can be used to describe "innovation processes for the circular initiatives", where

“partner companies do not fall under a particular categorization for a CBM as they are still linear business models working with implementing circular initiatives”. In this vein, circular-oriented innovations entail a strategic alliance that leverage on open innovation to enable CE practices implementation, in the form of businesses response to address the CE transition (Bocken & Ritala, 2021; Eisenreich et al., 2021; Jesus & Jugend, 2023; Köhler et al., 2022).

When pursuing the introduction of a circular innovation, organisations typically face tricky challenges in the form of complex and disruptive changes. As observed in multiple corporate sustainability reports by Stewart and Niero (2018, p. 1012), “several companies have initiated or engaged in active dialogue with, for example, peers, knowledge partners, value chain partners and regulators, to explore the role of CE in their specific business”. Consequently, business initiatives typically engage in project-specific partnerships to overcome the technical and structural barriers related to circular product or process development (Bressanelli et al., 2019; De Angelis et al., 2023; Suchek et al., 2021; Wrålsen et al., 2021). Johnson (2022) specifically observed as companies seek for stakeholders’ collaboration to embrace circular oriented innovations due to a lack of capabilities and knowledge. Strategic alliances are thus intended to access tangible and intangible critical resources such as specific materials, machinery and space, knowledge or people skills, as well as accessing to competences related to governance and managerial structures to carry out circular oriented innovations (Boldrini & Antheaume, 2021; Sehnem et al., 2022; Tapaninaho & Heikkinen, 2022). Leder et al. (2020) employed a systematic review and a focus group investigation to gather information about waste valorisation, outlining stakeholders’ collaboration as an “inevitable element” that lead to value creation in circular business models. Accordingly, Paletta et al. (2019) emphasised the importance of strategic collaboration in the recycled plastic domain. In order to dispose of recycled plastic, manufacturing companies need to interface with stakeholders operating in waste management so plastic converters facilitate access to recovered resources according to customers' prerequisites. This is the case of project-specific collaborations aimed at developing circular products or processes. Another example is offered by Cantele et al. (2020), the authors reported the case of a stationery supplier and an electrodes producer that jointly designed and developed a pencil made by graphite powder waste. Circular oriented innovations, in terms of product and process, provided a specific knowledge base about recovering and

upcycling graphite that the first company leveraged later on the development of other innovative one-to-one projects with fashion companies. In these case, strategical project-specific partnership allowed to experiment with the possibilities of remanufacturing processes, which showed to be instrumental for establishing the circular business. Jensen et al. (2019) also investigated remanufacturing practices implementation by two businesses, where such circular practices are undertaken in conjunction with a business partner that is also a sustainability-oriented enterprise acknowledged about remanufacturing processes. Overall, circular project-specific collaboration showed to be a recurring inter-organisational pattern through which companies can carry out circular oriented innovations. According to this perspective, this inter-organisational formation showed to typically involve business entities aligned by the same vision to reduce the use of resources or energy in production cycles, as well as the waste resulting from their activities (Brown et al., 2019; Camilleri et al., 2023; Cantele et al., 2020; Tseng et al., 2022).

Dwelling on strategic alliances aimed at translating circular principles into feasible practices, Brown et al. (2021a, 2021b) specifically identifies six phases related to the collaborative process establishment. In the first place a company identifies its needs in terms of knowledge, competences, tools, and resources, to proceed later by communicating its intention to collaborate (Boldrini & Antheaume, 2021; Johnson, 2022). A careful selection of partners follows, with the aim of setting a shared vision on which to consequently structure collaborative processes and define the dynamics of value creation, delivery, and capture (Pereira & Vence, 2021; Ranta et al., 2018; Tapaninaho & Heikkinen, 2022). Once these preliminary steps have been settled, businesses are required to undertake joined activities and collaborate on the implementation of circular-oriented innovations (Brown et al., 2020 Eisenreich et al., 2021; Köhler et al., 2022; Stewart & Niero, 2018). Jäger and Piscicelli (2021, p. 737) also showcased a “collaboration set-up process”, which includes five phases from motivation and need assessment, market and material flows understanding and vision alignment, the assessment of internal and external resources, partner evaluation and involvement, to the final agreement of every stakeholder.

Considering project-specific partnership aimed at developing circular oriented innovations, strategic alliances showed to be typically structured according to a defined time horizon toward the realisation of the circular product or process in

question (Brown et al., 2019; Cantele et al., 2020; Pereira & Vence, 2021). In this case, the partnership involves a limited number of companies, strictly related to the need for resources or capabilities required while carrying out the joint innovation project (Eisenreich et al., 2021; Jensen et al., 2019; Johnson, 2022; Tapaninaho & Heikkinen, 2022). The same companies involved are called upon to administer the governance of the collaboration, coordinating innovative efforts to develop circular products or processes. In contrast to the subsequent scenarios, in circular project-specific collaborations, it was possible to observe how there is not typically a predominant figure in charge of coordinating or orchestrating the strategic alliance (Brown et al., 2021b; Cantele et al., 2020; Jensen et al., 2019; Paletta et al., 2019). The equal involvement of actors in decision-making and steering the strategic alliance is rather more pronounced, also according to the low number of actors involved.

In conclusion, circular project-specific collaborations represent an attempt to build circular businesses based on restricted companies' alliance. As suggested by the literature, it happens this kind of strategic alliance to last according to the duration of the circular project (Cantele et al., 2020; Jensen et al., 2019). Alternatively, it represents the spark that brings companies to include new entities in the creation of a larger scheme designed to generate new market opportunities by rethinking product value chains, or by establishing ecosystems that operate according to CE principles across a broad spectrum of activities (Carraresi & Bröring, 2021; Kanda et al., 2021; Moggi & Dameri, 2020).

2.4.3 Circular supply chain

The theoretical roots of circular supply chain management lie in various disciplines. Drawing on logistics and operations management literature in defining a supply chain (Bechtel & Jayaram, 1997), previous authors introduced the concept of sustainable supply chain management and green supply chain management. Supply chain management, which entails the optimisation of information, product, and capital flows within a system to maximise efficiency, responsiveness, and resilience (Mentzer et al., 2001), has been further integrated by the triple bottom line interpretation of sustainability (Elkington, 1994). As such, the sustainable supply chain management represents a holistic approach that aims to balance economic, social, and environmental outcomes from supply chain activities (EMF, 2013; Seuring & Müller, 2008). It ensures business operations to be financially

profitable, besides contributing to society and minimizing environmental impact over the entire value chain. On the other hand, green supply chain management is a narrowed approach to sustainable supply chain management that mainly pursue to address the environmental pillar of sustainability. It focuses on minimizing the environmental impact of supply chain activities recurring to environmentally friendly practices and strategies into the design, production, sourcing, logistics, and distribution of products and services to achieve a more environmentally sustainable operations (Pohlmann et al., 2020; Srivastava, 2007). Accordingly, the CE literature outlined CSC as an additional configuration affering to the broader concept of sustainable supply chain management (De Angelis et al., 2018; Farooque et al., 2019; Lahane et al., 2020).

The transition towards a CE brings traditional supply chains to be rethought according to sustainable opportunities, which can be specifically exploited reducing resources depletion or recovering waste as new inputs in the value chain (Aarikka-Stenroos et al., 2022; Bressanelli et al., 2019; Eisenreich et al., 2022; Vegter et al., 2020). Then, it is possible to describe CSCs through the integration of CE principles in supply chain management, where the harmonisation of forward and reverse logistics allows multiple actors to establish a renewable system in a closed loop value chain (Butt et al., 2023; Lahane et al., 2020; Tseng et al., 2022). Observing the coordinated adoption of CE practices by the actors gathered around the same value chain, the term circular supply chain has been introduced in literature as a collaborative strategic approach to support circular principles integration in businesses (Aray et al., 2022; Carraresi & Bröring, 2021; De Angelis et al., 2018; Mishra et al., 2021; Tseng et al., 2022). Drawing on the definition advanced by Farooque et al. (2019), circular supply chain management can be described as “the integration of circular thinking into the management of the supply chain and its surrounding industrial and natural ecosystems”. Thus, circular transition toward a renewable system in the supply chain dimension is based on industry specific inter-organisational collaboration (Ciulli et al., 2020; Gebhardt et al., 2022; Sudusinghe & Seuring, 2022), where multiple independent actors committed to join value chain activities designed for pursuing common objectives and mutual benefits (Cao & Zhang, 2011; Soosay & Hyland, 2015). Leising et et al. (2018), investigating supply chain collaboration in the building sector, advocate how inter-organisational relationships are essential to create closed loop supply chains that wink at a CE transition. In agreement, authors such as Bocken et al.

(2016), Ghisellini et al. (2016), and Mishra et al. (2021) also emphasised collaboration as fundamental element in shaping a circular practices and processes. "When closing and slowing material loops, it is essential to include the supply chain as a whole, and to involve all parties from design and raw material suppliers to end users, service providers and recyclers, including the associated information flows" (Leising et al., 2018, p. 977). Questioning the role of designers in companies' circular transition, Dokter et al. (2021, p. 703) highlighted the "multi-faceted challenge" represented by CE "that further expands the scope of design processes and projects". From designers' side, the successful implementation of a CBM demand cross-disciplinary knowledge arising from stakeholders' extensive collaboration in each value chain step. Indeed, strategic alliances thought to involve supply chain members into a network are described in various studies as a critical requirement to effectively implement circular supply chains. Tseng et al. (2022, p. 743) outlined how "the collaboration within the value chain is seen as a critical facilitator for the transition process" in embracing a renewable production and consumption system. Drawing on Hussain and Malik (2020) and Rizos and Bryhn (2022), collaboration can be considered a process facilitator that enable circular transition in circular supply chain structures, besides supply chain configurations. The authors supported the link between inter-organisational collaboration and environmental performance of the supply chain, based on an "enhanced information and technology sharing in the supply chain network" (Hussain & Malik, 2020, p. 9). As a result, Eisenreich et al. (2022, p. 9) advanced a "circular value chain framework" as an adjustment of the value chain framework showcased by Porter (1985, p. 37), to suits better the crade-to-crade logic related to the CE domain and the interrelationships among the external stakeholders.

The literature echoes the concept of industrial symbiosis from a supply chain management perspective (e.g. Cavicchi & Vagnoni, 2021; Mulrow et al., 2017), although a clarification is in order. As a collective approach based on geographically close companies pertaining to separate industries, industrial symbiosis involves the exchange of resource and materials to achieve a competitive advantage (Chertow, 2007). This strategic approach, typically associated with system formations (Baldassarre et al., 2019; Fraccascia et al., 2019; Pavan et al., 2021), has been further expanded by Lombardi and Laybourn (2012, p. 31) according to a holistic view of intra-organisational collaboration, where companies pursue to "foster eco-innovation and long-term culture change"

recurring to symbiosis. Coherently, it is possible to conceptualise industrial symbiosis in supply chain management as long as traditional and symbiotic actors from various sectors exchange resources and materials operating around a specific value chain (Turken & Geda, 2020; Yu et al., 2021). In this vein, symbiotic actors concur to define a circular supply chain where companies pursue to close, narrow, and slow resource ad energy loops (Bocken et al., 2016; De Angelis et al., 2018; Geissdoerfer et al., 2018).

In practice, recurring to a circular supply chain strategic alliance, companies can retrieve value from end-of-life products and recover scraps from transformation processes. This inter-organisational formation has been recognised as valuable strategy to recover value from waste, in order to establish a zero-waste supply chain by collaborating with industry's stakeholders (Carraresi and Bröring, 2021; Cavicchi & Vagnoni, 2021; Ciulli et al., 2020; Mishra et al., 2021). Coordinated procedures and mechanisms in a circular supply chain, or even involving multiple supply chains, allow residual waste or scraps from certain processes to become sources for another value chain step (Farooque et al., 2019; Leising et al., 2018; Tseng et al. 2022). Lahane et al. (2020) also supported as natural resources can be restored and regenerated to enhance their exploitation, thanks to an accurate circular supply chain management. Therefore, strategic alliances are fundamental in circular supply chain management to establish circular practices and, building on the present review, we can advance some recurring patterns in these inter-organisational relationships. The collaboration mechanisms underlying circular supply chain functioning were categorised by Gebhardt et al. (2022) in information and resource sharing (Barratt, 2004; Olorunniwo & Li, 2010), mutual knowledge creation (Chan & Prakash, 2012; Malhotra et al., 2005), joint planning and decision making (Barratt, 2004; Olorunniwo & Li, 2010), contractual and economic practices' formalisation (Cloutier et al., 2020).

Drawing on previous studies (Barratt, 2004; Soosay & Hyland, 2015; Sudusinghe & Seuring, 2022), these practices can be arranged on vertical, horizontal, and lateral collaborations. They respectively represent interactions with upstream or downstream stakeholders, organisations at the same level of the supply chain or other external parties of competing supply chains, and the combination of the two forms. In addition, the transition toward a circular supply chain may require crossing industry boundaries, outlining an additional collaboration direction in the form of systemic interactions (Gebhardt et al., 2022). Shultz et al. (2021), agreeing

with De Angelis et al. (2018) and Farooque et al. (2019), also support how circular supply chain development especially requires companies to give emphasis on the horizontal dimension to collaborate with multiple partners within and outside the core industry. Dealing with sustainable opportunities while pursuing a renewable production and consumption system, entails the interplay of more actors characterised by heterogeneous backgrounds (Aray et al., 2023; Tseng et al. 2022). Accordingly, the interaction of multiple stakeholders leads to revise traditional value chain formations, outdated for dealing with sustainable purposes. "Potential new specialised competitors, alone or in networks, enter the market with better practices, leading to new value chain emergence and in turn business model innovation, and triggering value redistribution among players" (Carraresi & Bröring, 2021, p. 10). In this vein, circular businesses involve additional layers of complexity to supply chains, as well as about the ownership of circular innovations and the distribution of costs and benefits among partners in the circular supply chain (Rizos & Bryhn, 2022). Specifically referring to cross-industry partnerships, Carraresi and Bröring (2021) stresses this point emphasising how the establishment of new relationships with companies belonging to akin value chains concours to improve companies' resilience in approaching a sustainable transition (Carayannis et al., 2014). In addition, another circularity facilitator has been found in supply chain configuration supported by structural flexibility of the actors in shaping material loops along the supply chain (De Angelis et al., 2018). Compared to a traditional value chain structure, the pronounced flexibility observed in circular supply chain supports businesses in addressing uncertainties and complexities related to supply chain management. In this vein, it allows to develop sustainable product and processes, minimize resource consumption, and enable the use of environmental technologies (Bai et al., 2020; Liu et al., 2022).

The coordination of multiple actors along value chain stages thus allows to slow, narrow, and close resource and energy loops (De Angelis et al., 2018; Leising et al., 2018). In general, Pohlmann et al. (2020) identified primary stakeholders as the actors directly involved in supply chain operations (e.g. manufacturers, suppliers, distributors, and consumers), while secondary stakeholders are typically embodied by organizations indirectly involved in the supply chain (e.g. intermediaries, public entities, nongovernmental organizations, and media). Drawing on the case study advanced by Hansen and Revellio (2020), actors can find a specific categorization in closed-loop supply chain according to their role.

The authors highlighted manufacturers and retailers as central coordinator, typically positioned between suppliers and end users. Circular practices such as repair, reuse, remanufacture, and recycle are carried out either by the supply chain coordinator or loop operators, represented by support entities that join the circular supply chain. The coordinator role is covered by "forward-looking companies able to recognize opportunities in sustainability transition, to manage complementarities and to absorb disturbances going through necessary modifications to respond to disruptions" (Carraresi & Bröring, 2021, p. 10). They act as focal companies within the circular supply chain, intended to coordinate the activities of other upstream or downstream actors as well as those operators supporting loop strategies. Pohlmann et al. (2020) also pointed out the presence of focal companies that provides leadership and exercises the most significant control over decisions and activities in a CSC. Their coordinating role involves designing the circular product or service offered, besides promoting triggers for supply chain management in terms of structuring organisations' involvement along the value chain (Pohlmann et al., 2020; Seuring & Müller, 2008).

2.4.4 Circular ecosystem architecture

The ecosystem perspective of circular businesses collaboration builds on different construct from literature including sustainable business models (Bocken et al., 2014), industrial ecology (Ashton, 2008), industrial symbiosis (Chertow, 2007), and business ecosystems (Iansiti & Levien, 2004). A circular ecosystem architecture, at first, is established on the interaction of sustainable-oriented businesses, especially inclined to the development of a closed and renewable system within the collaborative environment boundaries (Baldassarre et al., 2020; Bocken et al., 2014). On the other hand, industrial ecology offers some theoretical foundations for the CE discipline as a starting point for ecosystem perspective. It advances the interpretation of "natural ecosystem as a metaphor for the design of industrial systems" where companies attempt to close, narrow, and slow resource ad energy loops (Bocken et al., 2016; Kanda et al., 2021, p. 2815). In more detail, the industrial ecology branch of literature also explores industrial symbiosis as the establishment of a cooperative network of businesses based on resources and by-products exchange, as well as the common exploitation of infrastructure and services aimed at achieving competitive advantage besides environmental impacts reduction (Chertow, 2007; Yu et al., 2021; Zaoual & Lecocq, 2018). Drawing on the industrial ecology construct, actors' interaction in a renewable system supports

the creation of a local ecosystem aggregation of organisations through an industrial symbiosis arrangement. As a strategic approach to establish inter-organisational collaboration, industrial symbiosis engages traditionally separate industries and actors in a systemic environment to capitalise on the synergistic possibilities offered by geographic proximity (Chertow 2007; Wolf et al., 2007). Baldassarre et al. (2019) employed industrial ecology in the CE domain as conceptual lenses to investigate a network of businesses based on industrial symbiosis, in the intention of outlining actors' commonalities and differences. Further on, industrial symbiosis application in circular businesses has also been addressed by Fraccascia et al. (2019) as a system perspective to analyse the governance of a circular system characterized by numerous firms. In line with the business ecosystem properties, a CE ecosystem incorporates both production and consumption-side participants, including complementary asset providers and customers (Iansiti & Levien, 2004; Yu et al., 2021). It allows circular ecosystems to stand out from alternative interorganisational formations that are typically focused on either production or consumption-side participants (Kanda et al., 2021).

In general, CE practices implementation triggers companies to cross their boundaries. Leaving a firm-centric focus, sustainability-oriented organisations are typically forced to interact with other actors in shaping a collaborative environment (Geissdoerfer et al., 2020; Kanda et al., 2021; Pieroni et al., 2019). In this vein, an ecosystem architecture concours to redefine companies' business models where multiple economic organizations, consumers, public entities, and institutions interact dynamically to create economic, social, and environmental value (Zaoual & Lecocq, 2018; Zucchella & Previtali, 2019). Konietzko et al. (2020) identified a circular ecosystem "as a set of actors – producers, suppliers, service providers, end users, regulators, civil society organizations – that contribute to a collective outcome" in terms of achieving circularity. The ecosystem assessment highlights the interdependencies between different organizations and provides a lens to analyse value co-creation through systemic innovations. In this vein, Nogueira et al. (2023) outlined three cases where ecosystem innovation played a fundamental role in realising waste valorisation initiatives, proving that markets innovation seem to be lacking in pursuing these kind of sustainable opportunities. Tapaninaho and Heikkinen (2022) explored value creation in circular ecosystems, recognising stakeholders' evolving interactions as an effective mechanism to cope with the multiple facets of circular

practices. Indeed, the authors found how “the local ecosystems are characterised by constantly evolving stakeholder relationships as new stakeholders join and others exit to seek optimal ecosystems and CE activities for their aims” (Tapaninaho & Heikkinen, 2022, p.2734). Also, Moggi and Dameri (2021) highlight how several stakeholders, which differs in terms of industries and scope, can collaborate in a circular ecosystem to create shared value. The case study pictures how actors’ interactions support food waste reduction in an urban context by collecting, donating and redistributing surplus food to the needy in the local community. More specifically, business ecosystems do not follow the linear value creation process and, thus, many of the actors in such collaborative environments are outside the scope of the traditional value creation chain setting (Barratt, 2004; Iansiti & Levien, 2004; Soosay & Hyland, 2015). Heterogenous entities and organizations, sometimes even competing with each other, take part in circular process or product development by gathering resources or delivering services to other actors. In this vein, members of a circular ecosystem deliver value through an interrelated system of interdependencies rather than as independent entities, horizontally broadening the boundaries of individual value chains to embrace realities and knowledge from different sectors (Nogueira et al., 2023; Tapaninaho & Heikkinen, 2022).

Business ecosystem’s orchestration capabilities, related to identifying and coordinating partners in a strategic network, were therefore found to be highly relevant in CE development (Parida et al., 2019; Geissdoerfer et al., 2020; Santa-Maria et al., 2022). Bringing together heterogeneous and previously unconnected actors from different industries, as well as other research entities, institutions or end consumers, stimulates out-of-the-box thinking to deal with sustainable opportunities from multiple angles (Konietzko et al., 2020).

According to natural ecosystems functioning, this form of collaboration is structured as a nested commercial system populated by character-specific players that concur to an overarching solution or ecosystem-level goals coherent with CE principles (Christensen & Rosenbloom, 1995; Nambisan & Baron, 2013; Zaoual & Lecocq, 2018). Zucchella and Previtali (2019) explored two issues related to ecosystem’s actors and their role in establishing circular processes and products. More specifically, the authors highlighted the presence of a focal actor, which behaves as orchestrator of the circular network in sailing the other actors through the circular project. This figure typically generates trust and commitment among

companies and entities involved in the collaborative network, while promoting communication about the share vision and any opportunities in a win–win-win strategy (Elkington, 1994; Zaoual & Lecocq, 2018). The authors introduced a second element that supports the development of circular practices, in terms of the ecosystem mechanisms related to actors' interactions (Zucchella & Previtali, 2019). In this view, companies and institutions involved in a circular ecosystem cannot be identified as stand-alone entities, instead they play a specific and fundamental role for network thriving. Drawing on Neutzling et al. (2018), the links among entities are based on tangible and intangible resource sharing, for instance monetary investments and critical sharing of knowledge for enabling circular practices development (Tapaninaho & Heikkinen, 2022). Moggi and Dameri (2021) outline how several stakeholders from various industries and scope can collaborate in a circular ecosystem to create shared value. In particular, the case study describes how actors' interactions support food waste reduction in an urban context by collecting, donating and redistributing surplus food to the needy in the local community. Another critical aspect is actors' effective intention to collaborate, an element not to be underestimated considering organisations' heterogeneity as well as their specific needs and interests, eventually also contrasting. Organisations are required to cooperate by looking beyond their individual interests to pursue the objectives of the whole system (Bressanelli et al., 2022; Parida et al., 2019). Finally, the third key element outlined by Zucchella and Previtali (2019) is represented by formal and informal governance agreements that regulate ecosystem mechanisms. Activities organisation and control, command structures and legal contracts are important conditions to regulate actors' activities in the network in the long term, as well as informal arrangements based on trust, communication, and cultural socialization (Zucchella & Previtali, 2019).

Integrating circular principles into business models requires a systemic view that encompass the involvement of multiple stakeholders and their constructive interactions, in order to give raise to circular businesses (Moggi & Dameri, 2021; Zucchella & Previtali, 2019. Simultaneous collaboration among heterogenous actors take place, where new stakeholders join the ecosystem while others are leaving it in a constantly evolving intertwined relationships.

2.4.5 Wrapping circular-oriented strategic alliances up

After a thorough review of the literature that led the authors to deliver the previously presented clusters, this section is intended for briefly summarising the differences between the three forms of inter-organisational setting that have emerged from previous studies. According to the previous description of each cluster, the authors reported in Table 3 the highlight resulting from the thematic analysis. Circular project-specific collaboration, circular supply chain, and circular ecosystem architecture are categorised according to the time horizon of the collaboration, partners involved, the structure of stakeholders' relationships, the governance of the inter-organisational formation, and its scope.

Table 3. Wrapping circular economy-oriented strategic collaborations

	Circular project-specific collaboration	Circular supply chain	Circular ecosystem architecture
Duration	Short-term perspective	Medium/long-term perspective	Long-term perspective
Stakeholders	Limited project specific partners	Downstream and upstream stakeholders (mainly)	Cross-industry partnership
Structure	Semi-stable relationships among actors	Semi-stable relationships among actors	Evolving stakeholders' relationships network
Governance	Project-related partner agreement based on shared values	Supply chain coordinators and loop operators, Focal actor as coordinator of the supply chain alliance	Focal actor as orchestrator of the ecosystem
Stakeholders' affinity	Businesses suitable for project development	Businesses from the same product value chain, besides some actors from related one	Actors from the same local context
Scope	Focus on carrying out a specific circular oriented innovation	Focus on a specific value chain	Wide focus on multiple value chains and industries
Alliance ties	Temporary	Semi-persistent	Persistent
Involvement	Production side	Production side	Production and consumption side

Source: Authors' elaboration.

2.5 Discussion of the results and future avenues

The literature stream examined through the systematic review represents the first attempt to comprehend the CE from a meso-level perspective. In this vein, we recognised in previous studies the effort in shedding light on inter-organisational collaboration as a fundamental element to achieve a renewable production and consumption system. However, we came across a fragmented and sometimes confusing literature that demand for a compass to guide academics and

practitioners in choosing from different strategic approaches while dealing with the CE transition.

As a premise, the main limitations of this study are mostly related to the methodology employed in our systematic literature review. In this sense, although the focus on peer-reviewed articles extracted from multiple scientific databases (i.e., Scopus, Web of Science) is based on quality and validity concerns, we do not consider other document types such as book' chapters, conference proceedings, non-peer-reviewed paper and practice-based journals. On the other hand, even though we recurred to cross-referencing snowballing at the end of the paper selection process, this method suffers from poor randomised representativeness so, despite our effort, we may have missed some interesting contributions because of different indexing on databases. Finally, the lack of empirical investigation to address our considerations can represent a limitation at this stage, but it also means a valuable suggestion for future research.

Our results suggest as the branch of literature studying the circular economy from a meso-level perspective is still in a preliminary stage, mainly focused on the exploration of phenomena through inductive comprehension processes. In this vein, most of the studies are represented by qualitative research and reviews of existing literature. According to a positivistic circle (Eisenhardt, 1989; Piekkari & Welch, 2018), future studies may adopt a deductive reasoning to theory building by assessing previous findings through empirical observation on a generalisable sample. In line with previous authors' recommendation (e.g., Averina et al., 2022; Butt et al., 2023; Ciulli et al., 2019; Lahane et al., 2020; Liu et al., 2022; Pieroni et al., 2019; Santa-Maria et al., 2022; Sarja et al., 2021; Sehnem et al., 2022), we thus emphasise that future studies should focus on developing quantitative methods to empirically assess theories, measurement models to test hypothesis through survey or paned data, and tools to support decision making.

Based on the sampled studies, as a first element of discussion, we stress the importance of collaborating with external partners in developing circular product and processes. Approaching a circular transition involves radical changes of the usual production and consumption pattern, which require innovative effort from companies to reinvent their business models according to a cradle-to-cradle-designed economy. Alliance with partners (e.g, Cooper & Claxton, 2022; Jager & Piscitelli, 2021; Jensen et al., 2019; Paletta et al., 2019), among companies from the same supply chain (e.g., Aarikka-Stenroos et al., 2022; Aray et al., 2023;

Bressanelli et al., 2019; Carraresi & Bröring, 2021; Ciulli et al., 2020; De Angelis et al., 2018; Mishra et al., 2021), or stakeholders interconnected into an ecosystem architecture (e.g., Kanda et al., 2021; Moggi & Dameri, 2021; Zaoual & Lecocq, 2018; Zucchella & Previtali, 2019) proved to support the CE transition through the development of innovative circular product and processes. Indeed, sustainable innovations are typically more complex to achieve due to the radical changes they involve. Inter-organisational collaboration, in different patterns, allow businesses to leverage on resource and critical knowledge sharing to address barriers toward the circular transition (Galvão et al., 2022; Perotti et al., 2024; Seles et al., 2022; Wade et al., 2022). As a result, collaborative initiatives such as circular project-specific collaborations, circular supply chains, or circular ecosystem architectures represent a reliable approach to foster the transition toward a renewable production and consumption system.

Considering the empirical article that depicted these three strategic collaborative approaches, we found an uneven commitment to unravelling these collaborative settings. Prior research has predominantly focused on circular supply chain management, with relatively limited attention given to the examination of circular ecosystems. Moreover, the most unexplored cluster concerns the unveiling of fixed-term strategic collaborations aimed at the development of specific projects. Seeing the current notable imbalance in the extent to which these three collaborative approaches have been explored in the existing body of literature, we encourage future studies to fill such gap. Therefore, more studies are needed to properly comprehend these phenomena, specifically referring to circular ecosystems and project-specific collaborations aimed at developing circular-oriented innovations.

In addition, no study has addressed multiple collaborative approaches simultaneously yet. Both inductive and deductive empirical studies are required to explore and assess similarities and differences of the outlined collaborative approaches. Academics and practitioners seek to acknowledge the implications of different collaborative settings in terms of stakeholders' interaction and resources exchange, as well as value creation and delivery from circular practices (Bressanelli et al., 2022; Moggi & Dameri, 2021). Empirical validation is needed to characterise the different approaches to provide decision makers with the appropriate tools to choose the most suitable collaborative strategy in support of the circular transition. More specifically, the CE literature falls short in

differentiating stakeholders' role and interaction in project-specific collaboration, circular supply chains, and circular ecosystems. Although previous studies highlighted the role of focal companies in circular networks (Konietzco et al., 2020; Polhmann et al., 2020), the figure of ecosystem orchestrator (Zaoual & Lecocq, 2018; Zucchella & Previtali, 2019) and supply chain coordinators (Carraresi & Bröring, 2021; Hansen & Revellio, 2020) should be better characterised, besides recognising new recurring figures in circular networks. Overall, stakeholders' contribution to the development of collaborative innovation aimed at tackling the CE transition has also been blurred so far. A focus on value creation, capture, and delivery in circular networks is also needed to further explore which kind of companies benefit more than others from these collaborations and to what extent (Cavicchi & Vagnoni, 2022; Kanda et al., 2021; de Vasconcelos Gomes et al., 2023). In this vein, a comparative assessment on shared value in collaborative network is missing, future research may want to assess the multidimensional value created and shared through the outlined collaborative networks (Tapaninaho & Heikkinen, 2022).

The theme of collaboration is closely linked to the exploitation of sustainable opportunities (Averina et al., 2022) through the development of circular oriented innovations (Brown et al., 2020; Pereira & Vence, 2021). More specifically, open innovation is echoed in each collaborative approach as a mechanism aimed at leveraging the sharing of knowledge, resources, and instrumental assets to come up with circular product and processes (Eisenreich et al., 2021; Jesus & Jugend, 2023). In this respect, it would be interesting to investigate how open innovation mechanisms are configured in the different approaches and their effectiveness. Previous authors such as Köhler et al. (2022) and De Angelis et al. (2023) referred to open innovation strategy in collaborative framework for circular economy by emphasising the role of dynamic capabilities. Drawing on Averina et al. (2022), in terms of competences, partners can provide resources that are not available internally or the company can contribute with specific resources. It represents another interesting element that deem further investigation, in order to explore the role of individual ad organisational capabilities in favouring collaborative innovation in circular networks (Santa-Maria et al., 2022; Sehnem et al., 2022).

Some research articles belonging to the sample analysed in this review (e.g. Blackburn et al., 2022; Ciulli et al., 2020; Langley et al., 2023; Leder et al., 2020; Liu et al., 2022), converge in elucidating how digital technologies can support

circular transition by fostering interrelationships of actors within circular networks (Yu et al., 2022). On the one hand, Blackburn et al. (2022) introduced the role of digital platforms in supporting ecosystem's orchestration mechanisms, and Langley et al. (2023) investigated the role of artificial intelligence in optimising circular production within and among industrial ecosystems. On the other hand, Liu et al. (2022) explored digital technologies innovation besides supply chain management in the post-covid economy, while Ciulli et al. (2020) assessed their supporting role in waste recovery considering a food supply chain. As a result, our data offer a considerable gap that future studies could fill by exploring how various forms of technological innovations can serve to support project-specific collaboration, circular supply chains, and circular ecosystems in terms of resource and information sharing, collaborative mechanisms coordination, and value creation and distribution monitoring. In general, it is necessary to shed light on what is the role of digitalisation in the implementation of circular practices and processes, and then to analyse specifically how new digital tools can foster collaboration between actors in a circular network.

In conclusion, we cannot avoid raising some concerns about the collaborative models explored. While collaboration can certainly stimulate the development of circular oriented innovation, the counter-side of the coin needs to be explored. Even though the circular economy seems to be a naturalised phenomenon (Adler et al., 2007; Perotti et al., 2023), future studies aimed at identifying mechanisms for attributing intellectual property rights to the outputs resulting from collaborative mechanisms are sorely needed. Similarly, it would be interesting to investigate the mechanisms for distributing the value created within the various collaborative approaches identified. This would help to understand whether there are collaborative approaches that more than others favour a fair distribution of costs and benefits of the activities carried out in a partnership, collaboration within the supply chain, or ecosystem characterised by a circular orientation.

Following our discussion of the results, Table 4a resume each gap and future recommendation we can deliver to specifically shed lights on circular project-specific collaboration, circular supply chain, and circular ecosystem architecture adopted to address the CE transition. Then, Table 4b showcase some future avenues recognised from our systematic review, theme that we encourage to be studied transversally in each collaboration pattern to unveil their different facets in businesses.

Drawing on the elements highlighted in our discussion, the authors can also provide a conceptual model to support future quantitative studies. In this sense, Figure 7 illustrates some of the factors influencing the implementation of CE in businesses, according to the business model dynamics of value creation, delivery, and capture. As this systematic literature review identifies three inter-organisational collaborative approaches, we advance their moderating role in affecting the weight of each identified factor towards CE implementation. As a result, we expect the choice of one collaborative approach over another to directly influence open innovation mechanisms, such as the instrumental use of digital technologies, the contribution of dynamic capabilities, and the extent of stakeholder relations.

Table 4a. Literature gaps and potential research avenues for future research: three collaboration pattern

Theme	Gap	Future research avenues
Project-specific collaboration	Limited exploration of fixed-term strategic collaborations aimed at the development of circular-oriented projects	RQ1) What are the key success factors for effective project-specific collaborations in the context of circular economy? RQ2) How do project-specific collaborations differ from other collaborative approaches in terms of their impact on circular economy transition? RQ3) What mechanisms can facilitate knowledge sharing and resource allocation within project-specific collaborations for circular innovation?
Circular supply chain	Predominant focus on circular supply chain management with relatively limited attention to stakeholders' exchange of resources and value creation and delivery from a closed loop supply chain	RQ4) How can circular supply chains be optimized to enhance resource efficiency and minimize waste in the production and distribution process? RQ5) What are the barriers and enablers for the adoption of circular supply chain practices among different industries and sectors? RQ6) How do circular supply chains contribute to value creation and distribution among stakeholders in the circular economy? RQ7) What are the different role assumbed by the stakeholders in a circular supply chain?
Circular ecosystem architecture	Limited exploration of circular ecosystems and stakeholders' role in supporting the circular economy transition	RQ8) How do circular ecosystem architectures facilitate collaboration and innovation among diverse stakeholders? RQ9) What are the characteristics of successful circular ecosystem architectures, and how can they be replicated in different local contexts? RQ10) What governance structures and mechanisms are effective in managing circular ecosystems for sustainable outcomes? RQ11) What are the different role assumbed by the stakeholders in a circular ecosystem architecture?

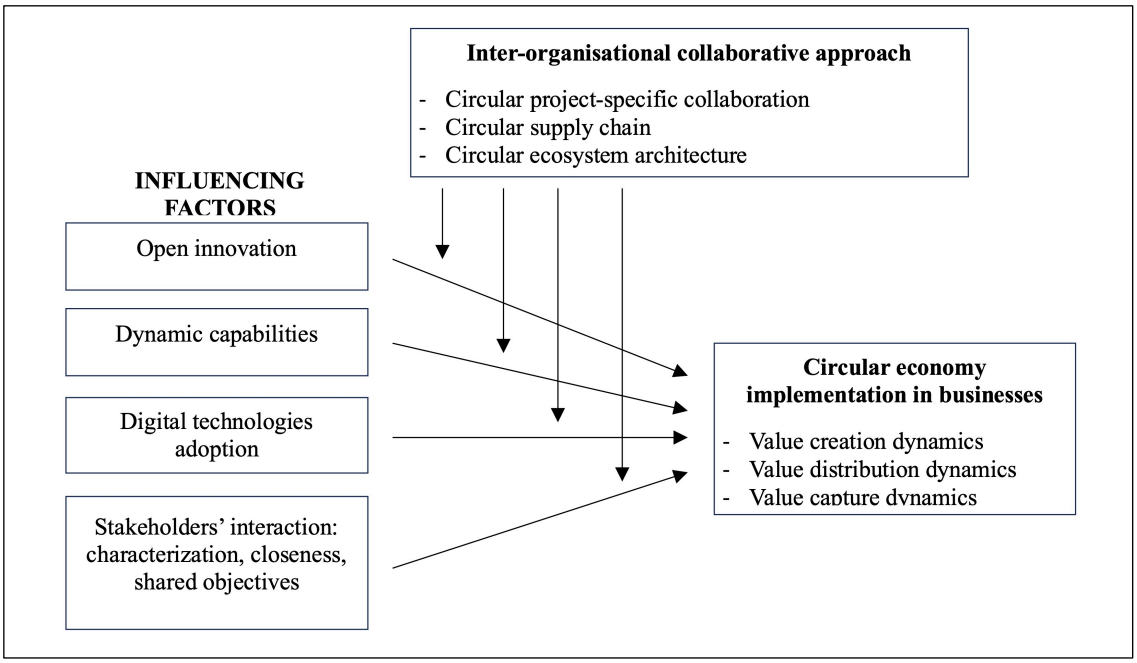
Source: Authors' elaboration.

Table 4b. Literature gaps and potential research avenues for future research: cross-cutting factors

Theme	Gap	Future research avenues
Value creation and distribution	Incomplete understanding of how value is created and distributed within collaborative networks in the circular economy	RQ12) What are the different dimensions of value created and shared through collaborative networks in the circular economy? RQ13) How do various collaborative approaches impact the distribution of costs and benefits among stakeholders in circular networks? RQ14) What mechanisms can ensure equitable and sustainable distribution of value in circular collaborations?
Stakeholders in circular network	Limited characterization of stakeholders' roles and interactions in different collaborative settings	RQ15) How do different stakeholders contribute to collaborative innovation in circular networks, and what are their specific roles and responsibilities? RQ16) What are the motivations and incentives for stakeholders to participate in collaborative initiatives for the circular economy? RQ17) How can stakeholder engagement and participation be optimized to maximize the effectiveness of circular collaborations?
Open innovation	Limited exploration of how open innovation mechanisms are configured and implemented in different collaborative approaches within the circular economy	RQ18) What are the key drivers and barriers for implementing open innovation strategies in different circular networks? RQ19) How do open innovation mechanisms facilitate knowledge sharing and co-creation of value in different circular networks? RQ20)What are the implications of open innovation for intellectual property management and value capture in circular collaborations?
Dynamic capabilities	Limited understanding of the role of dynamic capabilities in facilitating collaborative innovation in the circular economy	RQ21) How do organizations develop and leverage dynamic capabilities to adapt to the changing requirements of circular collaborations? RQ22) What organizational processes and structures support the development and deployment of dynamic capabilities for circular innovation? RQ23) How can dynamic capabilities be measured and assessed in the context of circular collaborations to drive continuous improvement and innovation?
Digital technologies	Inadequate exploration of the role of digital technologies in supporting collaborative efforts and enabling circular practices	RQ24) How can digital technologies (such as blockchain, IoT, and AI) be leveraged to enhance collaboration and coordination within circular networks? RQ25) What are the challenges and opportunities associated with the adoption and integration of digital technologies in circular collaborations? RQ26) How do digital technologies contribute to data-driven decision-making and performance optimization in different circular networks?

Source: Authors' elaboration.

Figure 7. Conceptual framework for future avenues



Source: Authors' elaboration using VOSviewer.

2.6 Contributions and implications of the study

The literature stream examined through the present systematic review represents an initial attempt to comprehend the CE from a meso-level perspective, specifically focusing on collaborative approaches among businesses to address the transition. Our study contributes significantly to this field by shedding light on the inter-organizational collaborations as a fundamental element for achieving a renewable production and consumption system within the CE framework. Throughout our review, we recognized the efforts made in previous studies to illuminate the importance of inter-organizational collaboration. This collaboration is seen as essential for navigating the complexities of the CE transition. By synthesizing existing literature, we aimed to provide a comprehensive understanding of the various collaborative strategies adopted by businesses in their CE endeavors. On the other hand, our review also highlighted a significant challenge: the fragmented and sometimes confusing nature of the literature surrounding collaborative approaches in the context of the CE. Despite the growing interest in this area, there is a lack of coherence and direction, making it difficult for businesses to choose appropriate strategic approaches.

As a result, the first key contribution of this study is the identification of such gap in the literature. By acknowledging the need for a guiding compass, we underscore the importance of further research and theoretical development in this field. This

includes the development of frameworks or models that can help businesses navigate the complexities of collaborative initiatives within the CE context effectively. Secondly, this systematic review provides a bibliometric overview of the literature that enriched a meso-level comprehension of CE. We outlined three distinct literature stream that supported our categorisation. Third, we provide the first clarification of different collaborative approaches, encouraging future studies to build on this distinction and further develop multiple alternatives for strategic collaborations in the CE domain. Forth, through our thoughtful discussion, this study offers a guide for academics who want to delve more deeply into this segment of literature and concretely proposes identified gaps and potential new avenues. Overall, the findings of our systematic review concur to enriching the CE literature.

Additionally, our study provides practical implications for businesses and policymakers. It emphasizes the importance of fostering a collaborative ecosystem where businesses can exchange knowledge, resources, and best practices to accelerate the transition to a circular economy. Chief sustainability officers, sustainability specialist, and general managers of sustainability-sensitive companies may use insights from our study to drive their CE transition by choosing the most suitable approach to establish circular practices, develop circular product and processed. Specifically referring to the focal actors of circular networks, our findings suggest managers designing supportive policies and incentives that encourage and facilitate collaboration among businesses.

In summary, our systematic literature review contributes to the understanding of collaborative approaches in the context of the circular economy transition. By highlighting existing knowledge gaps and providing implications for both research and practice, we aim to support businesses and decision makers in their efforts to navigate and accelerate the transition towards a more sustainable and circular economic system.

2.7 Conclusions

In conclusion, our systematic review of the literature pertaining to collaborative approaches in the context of the CE transition has provided valuable insights into the current state of research in such field. We have illuminated the importance of inter-organizational collaboration as a foundational element for achieving the goals of a renewable production and consumption system within the CE framework.

Through our analysis, we have identified three collaborative circular business models adopted by businesses to foster inter-organisational exchange and drive the transition towards a circular economy. In addition, our review also revealed the fragmented and sometimes confusing nature of the existing literature, indicating a critical need for further research and theoretical development to provide a guiding compass for businesses navigating this complex terrain.

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CHAPTER THREE

Fostering circular economy through open innovation: Insights from multiple case study[2]

Abstract

This study represents an empirical, comprehensive investigation of two different inter-organisational collaborative approaches, offering a novel perspective on collaborative circular business models in the modern economy. In this vein, we explore how open innovation strategies foster the implementation of circular economy practices within a circular supply chain and a circular ecosystem. In addition, we identify and characterise stakeholders' roles in facilitating the translation of circular principles into a viable business. An inductive theorising approach was employed, leveraging an explorative multiple case study methodology. Data were collected from 13 organisations involved in two collaborative networks, designed to establish upcycling practices to recover waste from the food and beverage industry. A critical realist philosophical positioning underpinned researchers' data collection and analysis. As a result, we outline the nature of two different collaborative approaches to pursue a regenerative production system through open innovation strategies: a circular supply chain and a circular ecosystem architecture. The characterisation of the coordinator and orchestrator of collaborative circular business models is also highlighted in our findings. In sum, this study contributes to the literature on circular economy by unveiling the role of open innovation in fostering circular business development. From a practical standpoint, it offers insights for managers of sustainability-oriented companies willing to implement upcycling practices.

Keywords: *circular business model, circular economy, collaboration, ecosystem, innovation, open innovation, supply chain, upcycling*

3.1 Introduction

Circular economy (CE) represents a highly discussed topic that has attracted the interest of policymakers, foundations, researchers and companies committed to a

[2] Perotti, F. A., Bargoni, A., De Bernardi, P., & Rozsa, Z. (2024). Fostering circular economy through open innovation: Insights from multiple case study. *Business Ethics, the Environment & Responsibility*.

thriving and sustainable future. Drawing on this approach to sustainability, the key to unlocking environmental and human well-being lies in a renewable production and consumption system, where resources are constantly re-employed, resulting in waste reduction and minimising environmental corruption (Bocken et al., 2016; Ellen MacArthur Foundation, 2013; Pieroni et al., 2019). Accordingly, sustainablesensitive organisations are gradually translating their practice and processes to conform with the CE principles by giving rise to circular business models (CBMs).

Companies have proved to be crucial in driving the transition from a linear to a circular approach, due to the propensity to innovate the business model in pursuit of efficient resource management, cleaner production and long-lasting and recyclable products (Aranda-Usón et al., 2020; Geissdoerfer et al., 2020; Konietzko et al., 2020; Sousa-Zomer et al., 2018). However, looking at the grand challenges that contemporary society is facing (e.g. climate change, resource depletion, food security and nutrition and biodiversity loss), the current endeavour seems to be deficient (Alonso-Munoz et al., 2022; Food and Agriculture Organization of the United Nations et al., 2022; United Nations, 2021b). For example, the world is currently 7.2% circular, and this rate is supposed to double by 2032 to avoid climate collapse (Circle Economy, 2023). It is also worth mentioning how global food waste from households and the agri-food industry is around 1 billion tonnes each year (United Nations, 2021a), besides nutritional imbalances and hunger (Food and Agriculture Organization of the United Nations et al., 2022). In the European Union, nearly 20% of the whole agrifood production is wasted or lost (European Commission, 2020). Overall, 360 million tonnes of scrap material originate from retail and food service throughout the world, which also implies a waste of energy resources used in the production processes, as well as the environmental impact of wastage in terms of a carbon footprint (United Nations, 2021a, 2021b). Building upon this background, we consider the food and beverage sector as fully sensitive to circular conversion in order to expand knowledge about the establishment of recovery practices in collaborative CBMs. These conditions relentlessly pose new challenges for policymakers, foundations, academics and managers in emphasising their efforts to support sustainable development (European Commission, 2020; Organisation for Economic Co-organisation and Development, 2020; Pizzi et al., 2020; United Nations, 2021b).

The extant literature advocates how CE offers an effective approach to achieve environmental ecosystem regeneration and longterm sustainable development (Averina et al., 2022; Bressanelli et al., 2022; Geissdoerfer et al., 2020; Konietzko et al., 2020). However, several barriers hinder the development of CBMs. In fact, earlier studies have highlighted how sustainability-oriented innovations demand a great amount of knowledge and collaboration, with the consequent need to approach and build partnerships with other organisations to develop circular processes and products (Appleyard & Chesbrough, 2017; Bogers et al., 2020; Brown et al., 2020; Enkel et al., 2009; Jabeen et al., 2022). From this perspective, interorganisational and cross-industry interactions have been recognised as facilitators of circular business development, but the literature still falls short in addressing stakeholders' relationships and collaborative mechanisms that lead to the development of collaborative CBMs (Bocken & Ritala, 2021; Brown et al., 2021; Khan et al., 2020; Santa-Maria et al., 2022).

Strategic alliances can facilitate the development of circular practices favouring supply chain collaboration and alignment in terms of technical and processual coordination towards actors' involvement in sustainable innovation development (Brown et al., 2021; Leising et al., 2018). By resource sharing, such as knowledge, companies go beyond competition to establish a collaborative environment characterised by knowledge sharing routines that support business interactions with a proper communication platform and knowledge channelling, as well as supporting effective governance (Chaudhuri et al., 2022; Köhler et al., 2022). Open innovation (OI) practices associated with inbound, outbound or coupled strategies have been shown to foster the innovative efforts of circular businesses and to deal with technological and technical barriers that stand in front of circular process implementation and product development (Jesus & Jugend, 2023; Madanaguli et al., 2023; Moggi & Dameri, 2021; Strazzullo et al., 2022). While a debate around this issue has begun among academics and practitioners, it represents an initial attempt to shed light on the complex dynamics regarding CE and IO intertwinement.

Building on this theoretical gap, numerous interesting insights can be derived by studying the parallels between OI approaches and sustainability (Bertello et al., 2023; Chesbrough & Di Minin, 2014; Ghisetti et al., 2015; Kennedy et al., 2017). While the concept of a closed environment in which research and development (R&D) activities take place with limited opportunities for exchange and interaction

has been overshadowed, there has been a rise in interactive network dynamics where organisations go beyond their boundaries to gather ideas, projects and technologies that can be used to innovate (Bogers et al., 2017; Chesbrough, 2003; Enkel et al., 2009). In this regard, the OI paradigm is shaped around a disruptive concept of the origination and implementation of ideas within the company's innovation process through external input (Appleyard & Chesbrough, 2017; Bogers et al., 2020). On the basis of this background, this study focuses on the strategic link that ties sustainability-oriented actors within two collaborative networks to unveil how OI strategies can support companies in embracing CE through upcycling (e.g. Aarikka-Stenroos et al., 2022; Leising et al., 2018; van Hal et al., 2019).

By employing a multiple case study approach, this article unravels how inbound, outbound and coupled processes can overcome barriers to the implementation of CBMs. Consistent with the inductive nature of this study, we adopted a critical exploratory approach to collect and analyse data from our observation of a circular supply chain and a circular ecosystem architecture (Bygstad et al., 2016; Lawani, 2021; Piekkari et al., 2009; Welch et al., 2022). Specifically, we analysed primary and secondary data from 13 companies, including private and public entities operating in the food and beverage, nutraceutical, cosmetics and manufacturing industries (Camilleri, 2021; Cavicchi & Vagnoni, 2022; De Bernardi et al., 2023; Venturelli et al., 2022). As a result, the examination of two circular networks revealed the effectiveness of IO strategies in implementing upcycling practices within companies, demonstrating how collaborative CBMs leverage critical resources and diverse expertise to drive circular-oriented innovations. Our findings also unveil the collaborative mechanisms and distinctive role assumed by focal actors in the circular supply chain and the circular ecosystem.

In summary, this study addresses the clear need to examine in more detail the benefits of strategic collaborations and OI strategies on collaborative CBMs. Building on the theoretical tenets offered by the resource-based view (Barney, 1991; Grant, 1991), besides the insights suggested by the stakeholder theory (Freeman, 1994, 2010; Parmar et al., 2010), we contribute to theory highlighting the intricate interplay between resources, knowledge and stakeholder relationships in achieving a competitive advantage and sustainable value creation across multiple dimensions. Enriching the eco-innovation literature at the intersection of CE and OI (Bocken & Ritala, 2021; Jesus & Jugend, 2023; Köhler et al., 2022),

our multiple case study emphasises the role of OI strategies, cross-supply chain alliances and cross-industry collaborations in fostering circular-oriented innovations (Bertassini et al., 2021; Moggi & Dameri, 2021; Tapaninaho & Heikkinen, 2022). In addition, this study provides insightful managerial implications to encourage collaborative approaches to address the CE transition, in order to address grand challenges through a renewable and restorative economic approach.

This article is organised into six sections. After the introduction in Section 1, Section 2 presents the theoretical underpinnings of the study, which led to the development of the research questions. Then, Section 3 describes the research design and the methodology we adopted, followed by the presentation of the results in Section 4. Section 5 provides a comprehensive discussion and Section 6 includes concluding remarks regarding the limitations of the study and future research avenues.

3.2 Theoretical background

3.2.1 The intertwining of circular economy and open innovation

The CE paradigm has become popular for many industries to build CBMs and to boost eco-innovation development (Geissdoerfer et al., 2017; Koszewska, 2018; Suchek et al., 2021). In this vein, the CE transition, from a linear model to a CBM, represents an innovation-intensive process of business re-organisation (Averina et al., 2022; Bocken et al., 2016; de Jesus & Mendonça, 2018; Perotti et al., 2023; Sharma et al., 2021). In the domain of innovation studies, the interconnection of environmental and social concerns alongside the need to foster economic growth has led academics to find different approaches to achieve corporate sustainability (Chesbrough & Di Minin, 2014; Ghisetti et al., 2015; Lin & Zheng, 2016), introducing the concept of eco-innovation. It is defined as ‘new or improved socio-technical solutions that preserve resources, mitigate environmental degradation and/or allow recovery of value from substances already in use in the economy’ (de Jesus & Mendonça, 2018, p. 77). In this regard, change is triggered by technical knowledge derived from the rise of sustainable innovations that enable firms to adopt new modes of sectoral organisation or new business configurations (Cillo et al., 2019; Jabeen et al., 2022; Johnson & Suskewicz, 2009; Pieroni et al., 2019).

By leveraging innovation management across multiple stakeholders, collaboration plays an essential role in overcoming the linear production system and fostering CBMs (Brown et al., 2021; Jesus & Jugend, 2023; Khan et al., 2020; Leising et al., 2018). In fact, CBMs entail cross-sectoral collaboration (Hazen et al., 2021; Witjes & Lozano, 2016) fuelled by a systemic approach that enables partnerships, knowledge sharing and collaboration to develop a competitive advantage (Borland et al., 2016; Köhler et al., 2022; Le et al., 2023). This system is propelled by the adoption of OI as a distributed process based on purposively managed knowledge flows across organisational boundaries (Bertello et al., 2023; Chesbrough & Bogers, 2014; Pan et al., 2023). OI appears to be the key approach to face the complexity and systemic nature of today's societal challenges and to foster the transition towards a more sustainable and digital economic model (Bertello et al., 2023).

The transition towards a CBM is indeed jeopardised by several barriers that prevent its adoption (de Jesus & Mendonça, 2018; García-Quevedo et al., 2020; Hina et al., 2022; Jabbour et al., 2020; Jaeger & Upadhyay, 2020; Kumar et al., 2019; Urbinati et al., 2021). More specifically, among those barriers academics pinpoint technologies as the most prominent but also find a lack of knowledge, ability and capacity among employees, and a lack of information about product design and production to enable the development of environmentally and sustainable products (de Jesus & Mendonça, 2018; Jabbour et al., 2020; Ritzén & Sandström, 2017; Shahbazi et al., 2016). Due to the collaborative nature of CE, academics have postulated that firms might benefit from the adoption of OI practices to mitigate the technological and technical barriers that prevent the implementation of CBMs (Brown et al., 2020; Jesus & Jugend, 2023; Venturelli et al., 2022). In a seminal work, Chesbrough (2003) defined OI as a concept that entails companies' exploitation of internal and external ideas to improve and accelerate their innovation processes, at the same time making their ideas, knowledge and technologies available to the external market environment. Accordingly, through exposure to different stakeholders, communities or ecosystems, companies evolve their business model (Camilleri, 2022; Jesus & Jugend, 2023; Konietzko et al., 2020; Strazzullo et al., 2022). The three types of OI knowledge flows (i.e. outside-in, inside-out and coupled processes) to which the firm is exposed actively facilitate the company's ability to acquire and

disseminate critical knowledge, leveraging inter-organisational collaboration to enhance innovation processes.

In conclusion, OI represents a key factor in driving CBMs which, through waste recovering from the value chain, provides companies with tangible benefits such as lower material cost and diminished resource dependence (Lewandowski, 2016; Urbinati et al., 2017). Companies interacting via CE networks thus benefit from inter-organisational resource sharing, increasing their chances of developing successful, circular-oriented innovations (Blomsma et al., 2023; Brown et al., 2020; Miranda et al., 2023). As a result, the intertwining of CE and OI paves the way to shape different forms of cooperation among actors in circularity-oriented collaborative models.

3.2.2 Disclosing collaborative circular business models

Considering the typical resource strategies of CBMs (i.e. narrowing, closing and slowing loops), Bocken and Ritala (2021) highlighted two innovation approaches characterised by distinct strengths and weaknesses. On the one hand, a closed innovation approach ensures more control and coordination of the entire innovation process but, on the other hand, an open approach to circular-oriented innovation allows organisations to gather and leverage more capabilities and resources (Appleyard & Chesbrough, 2017; Bogers et al., 2020; Brown et al., 2020; Enkel et al., 2009). In support of the second innovation path, previous research suggests that collaboration among several organisations may be an enabling and stimulating factor for CBM establishment (Bocken et al., 2016; Mishra et al., 2019; Rizzi et al., 2013; Sarja et al., 2021; Sohal & De Vass, 2022). Furthermore, some empirical studies have shown how the development of circular ecosystems or circular supply chains represents a solid base for the implementation of circular businesses based on new circular-oriented innovations, optimising resource employment and environmental ecosystem functioning (Bressanelli et al., 2019; Kanda et al., 2021; Konietzko et al., 2020; Venturelli et al., 2022). As described by Greco et al. (2015), the interface separating an organisation from external entities like its partners, sources of innovation or licensees can be likened to a partially permeable membrane. Knowledge moves across this boundary to varying extents and speeds (Fey & Birkinshaw, 2005). These degrees and rates of knowledge transfer can be affected by several factors, including the nature of the knowledge itself (whether it is easily codified and transferable), the dynamics of

the relationships involved (long-term relationships tend to facilitate exchange) and the inherent characteristics of the organisation and the stakeholders. In this regard, collaborative innovation has been discussed in previous studies, though the CE literature still falls short of specifically addressing the OI strategies in CBM innovation processes (Jesus & Jugend, 2023; Köhler et al., 2022). Researchers are gradually acknowledging the precise role of inter-organisational collaboration in enhancing the establishment of circular businesses, as well as the effects of stakeholder interdependencies on value creation and similar potential factors that may condition such an approach to sustainability.

Drawing from the CE literature, academics have proposed that inter-organisational collaboration is a critical factor in developing circular-oriented innovation. In fact, Brown et al. (2019, p. 3) defined circular-oriented innovation as 'the coordinated activities that integrate CE goals, principles, and recovery strategies into technical and market-based innovations, such that the circular products and services that are brought to market purposively maintain product integrity and value capture potential across the full life-cycle'. While circular-oriented innovation is a novel and little-understood concept, we can identify, in the collaborative innovation literature, some antecedents to the adoption of such innovation models (Veleva & Bodkin, 2018). In fact, the literature shows that the primary motive for exploring collaborative innovation is the increase in knowledge flows (Appleyard & Chesbrough, 2017; Bogers et al., 2017, 2020). Other reasons that push companies to adopt such models are the increased competitiveness and the market share of innovations, the access to resources or to new markets or the acquisition of new skills (Bocken & Ritala, 2021; Brown et al., 2019). However, circular-oriented innovation exposes the firm to opportunistic behaviours of the partners involved in the process (Pouwels & Koster, 2017). The potential partners involved in circular-oriented innovation must be aligned in terms of vision and sustainability policies to overcome the possibility of reputation pitfalls.

At the systemic level, in the same direction of circular-oriented innovation, academics have defined a circular ecosystem as 'a system of interdependent and heterogeneous actors that go beyond industrial boundaries and direct the collective efforts towards a circular value proposition, providing opportunities for economic and environmental sustainability' (Trevisan et al., 2022, p. 292). On the other hand, previous studies identified collaborative CBMs from the observation of the coordinated adoption of CE practices by the actors gathered around the same value

chain (Butt et al., 2023; De Angelis et al., 2018; Lahane et al., 2020). Circular supply chain management, as 'the integration of circular thinking into the management of the supply chain and its surrounding industrial and natural ecosystems' (Farooque et al., 2019, p. 884), has been recognised as a collaborative approach to pursuing circular-oriented innovations (Brown et al., 2019). Overall, a significant stream of literature focuses on the use of OI strategies to develop sustainable innovations (Bogers et al., 2020; Chistov et al., 2021; Rauter et al., 2019). Recent studies have approached open environmental innovation from various angles. For example, Mothe and Nguyen-Thi (2017, p. 2) defined open environmental innovation as the pursuit of external knowledge through practices like information sourcing, R&D acquisition and knowledge-sharing strategies. Another perspective, provided by De Marchi and Grandinetti (2013, p. 571) and Spena and Di Paola (2020, p. 3), characterises open environmental innovation as a strategic approach aimed at supplementing 'internal investment in green-specific resources with knowledge and competences coming from network partners' to foster eco-innovation. In summary, these definitions highlight several key aspects of open environmental innovation. First, it primarily seeks to reduce the environmental impact of organisations. Second, it places a significant focus on access to external physical and financial resources to foster information and knowledge exchange.

Through the theoretical lenses of the resource-based view (Barney, 1991; Chaudhuri et al., 2022; Muench et al., 2022), we posit that collaborative efforts within networks play a pivotal role in facilitating the transition to CBMs (Miemczyk et al., 2016), fostering sustained growth and gaining a competitive edge (Rodrigues et al., 2021). In the domain of supply chain and procurement research, the natural resource-based view theory has been recognised as a valid framework for understanding the link between sustainability-related resources, capabilities and a firm's competitive advantage (AlNuaimi et al., 2021; Andersen, 2021; Giacomarra et al., 2021; McDougall et al., 2022). Its application in the domain of CBMs (Farooque et al., 2022; Kusumowardani et al., 2022; Schmidt et al., 2021) allows one to investigate the antecedents of the CBM network structure, particularly supplier selection, as a fundamental component of sustainable supply chain management. The natural resource-based view theory, originally introduced by Hart (1995), represents an evolution of the resource-based view proposed by Wernerfelt (1984). The resource-based view suggests that companies develop their

capabilities based on underlying resources to attain a competitive advantage. These resources must simultaneously be valuable, rare, inimitable and non-substitutable (Barney, 1991), and the firm must have a strategy in place to leverage these resources and capabilities (Grant, 1991). The focus of this theory centres on internal, non-transferable organisational resources, such as assets, capabilities, processes, information and knowledge (Eisenhardt & Martin, 2000). In contrast, the natural resource-based view expands this perspective by incorporating the interaction between a firm and its natural environment, encompassing three interconnected strategic capabilities critical for achieving both business and environmental sustainability, and thereby securing a competitive advantage: pollution prevention, product stewardship and sustainable development (Hart & Dowell, 2011).

Moreover, when firms utilise collaborative business models, their cooperative strategic approach can be examined using the perspective of stakeholder theory (Freeman, 2010; Freeman et al., 2010). This cooperative strategic approach characterises a preference within companies to view their stakeholders as potential collaboration partners, rather than adversaries, as outlined by Strand and Freeman (2015). It is not just a matter of recognising that the interests of all stakeholders are interconnected and mutually dependent, but also that the relationships between firms and their stakeholders should exhibit this interdependence and mutual connection. In their seminal work, Adner and Kapoor (2010) described how business ecosystems are value-oriented networks composed of a number of heterogeneous stakeholders that are connected by transactions. Hence, the concept of ecosystem is used to describe the collaboration between different but complementary organisations that cooperate to create common system-level values (Bertassini et al., 2021; Jacobides et al., 2018). The development of these system-level values contributes to promote the development of radical and disruptive innovations in sectors that have the potential to grow and disrupt the current business and activities (Bertassini et al., 2021; Geels, 2012). Business ecosystems foster dynamic cooperation around innovations (Jacobides et al., 2018; Moore, 1993), leveraging network-oriented and externally focused perspectives to boost business scalability (Fuller et al., 2019). While disruptive innovations are usually complex and require stakeholders with shared values, the business ecosystems fill this gap by fostering the development of new capabilities within the network to foster cooperation and value capture (Kramer & Pfitzer, 2016).

In conclusion, addressing the CE transition requires companies to innovate at a higher rate by cooperating in a network, as opposed to operating as isolated units. Thus, OI processes play a central role to boost the adoption of circular practices by lowering technological barriers, such as a lack of knowledge, the availability of technical solutions and the modifications required to product projects and production processes (de Jesus & Mendonça, 2018; Ovuakporie et al., 2021; Ritzén & Sandström, 2017). Based on this theoretical background, we aim to empirically address how CE-oriented businesses establish inter-organisational partnerships and collaborations to engage in OI, as a strategy to introduce circular practices. In addition, we seek greater clarity in terms of strategic approaches to establish collaborative CBMs by closely studying a circular supply chain and a circular ecosystem architecture in addressing the CE transition. Thus, we are guided by the following research questions (RQs).

RQ 1: How do inter-organisational collaborations foster the adoption of CE strategies in companies?

RQ 2: What are the commonalities and differences between a circular supply chain and a circular ecosystem architecture as collaborative approaches to address the CE transition?

3.3 Methodology

To understand how sustainability-oriented companies apply CE principles through strategic alliances, the present empirical study has followed an inductive theorising approach characterised by a multiple case study design. Based on the definition advanced by Eisenhardt (1989, p. 534), we refer to the case study methodology as a ‘research strategy which focuses on understanding the dynamics present within single settings’. Thus, the intent is to ‘examine, through the use of a variety of data sources, a phenomenon in its naturalistic context, with the purpose of confronting theory with the empirical world’ (Piekkari et al., 2009, p. 569). Inductive theorising proved to be a fitting approach because we are dealing with an event characterised by unsatisfactory theoretical explanations (Edmondson & McManus, 2007). In this vein, previous studies have highlighted the need for additional empirical investigations aimed at building grounded theory to unravel stakeholders' inter-organisational relationships while addressing a circular transition (Jesus & Jugend, 2023; Khan et al., 2020; Köhler et al., 2022). Therefore, according to Yin (2014)

and Eisenhardt (1989), we have relied on a multiple case study design to investigate such contextually embedded phenomena.

Drawing on Welch et al. (2022), the research design follows an alternativist philosophical approach. Accordingly, this multiple case study places an emphasis on causal explanation and explanatory contextualisation of the cases via a holistic, not variable-oriented, approach (Ragin, 1992). The critical realism lens offers a different point of view for qualitative research: a case study explanation does not pass through the identification of potential cases for generalisation; rather, it is focused on explaining the mechanisms that give rise to a phenomenon (Easton, 2010; Lawani, 2021; Ragin, 1992). As such, the content's richness and an extensive analysis of the selected cases are privileged during the investigation. Thus, the theorising process is inclined to be a case-oriented explanation, to enhance a holistic and detailed causal and relational representation of the cases under investigation (Piekkari et al., 2009; Ragin, 1997). As an effective manner to build theory from a grounded phenomenon, we focused on tracing the causal process that brings about results in terms of CE strategies in the observed contexts (Bygstad et al., 2016; Strauss & Corbin, 1997).

3.3.1 Sample selection

Considering the intention to investigate a sample of firms prone to the adoption of CE principles, we employed purposeful sampling to select cases that would best represent the establishment of a collaborative CBM leveraging the interactions of multiple actors (e.g. Ciulli et al., 2020; Köhler et al., 2022; Leising et al., 2018; Perotti et al., 2023; Zucchella & Previtali, 2019). This approach allowed us to delve into two potentially insightful and relevant empirical cases, from which we could abstract grounded theory and contribute to the extant literature by answering our research questions (Eisenhardt, 1989; Santa-Maria et al., 2022; Strauss & Corbin, 1997). In particular, we considered the food and beverage sector because it provides one of the best realities to deepen OI dynamics within circular-oriented businesses, where companies interact with profoundly heterogeneous organisations and advance cross-industry collaborations (Bargoni et al., 2022; Cavicchi & Vagnoni, 2022; Ferraris et al., 2020; Venturelli et al., 2022). The choice of this domain also comes from the urgency of promoting circular businesses aimed at reducing waste and rethinking resource usage (i.e. virgin materials, water, energy) to act against environmental corruption (Alonso-Munoz et al., 2022; De

Bernardi et al., 2023; European Commission, 2020; Konietzko et al., 2020; United Nations, 2021a).

More specifically, this study is based on the observation of two separate collaborative settings (i.e. a circular supply chain and a circular ecosystem architecture), where different entities come together to translate CE principles into feasible practices through upcycling. First, we selected two companies operating in the food and beverage industry (Company A and Company H) and then extended the investigation to their stakeholders. As a result, the two case studies involve 13 companies based in Italy. We collected data from seven companies from the circular supply chain of Company A, and six organisations operating in the circular ecosystem orchestrated by Company H (Table 5). Given our intention to advance an in-depth investigation of contextualised phenomena (Easton, 2010; Piekkari et al., 2009; Ragin, 1992; Welch et al., 2022), the number of businesses we considered is thoroughly satisfactory based on previous comparable studies (Averina et al., 2022; Zucchella & Previtali, 2019).

Table 5. Descriptive information of the sample

Collaborative approach	Organis.	Industry	Size	Interviewee(s)
Circular supply chain	A	Food and beverage	Micro	Chief executive officer, business and product development
	B	Commerce	Large	Supply chain and innovation manager
	C	Commerce	Large	Supply chain manager
	D	Food and beverage	Small	Chief executive officer
	E	Food and beverage	Small	Chief executive officer
	F	Food and beverage	Small	Chief executive officer
	G	Food and beverage	Small	Chief technology officer
Circular ecosystem	H	Food and beverage	Medium	Chief executive officer, production manager, marketing manager
	I	Chemical	Medium	Chief executive officer, product manager
	J	Manufacturing	Small	Chief executive officer
	K	Pharmaceutical	Medium	Chief executive officer, head of R&D and business development
	L	Food and beverage	Small	Chief executive officer
	M	Research and education	Large	Scientific head and research team

Source: Authors' elaboration.

3.3.2 Data collection

According to the philosophical reasoning of this qualitative study, the approach to data collection evolved with the natural progression of the research (Piekkari et al., 2009; Ragin, 1992). In the first stage, an extensive preliminary desk investigation yielded various insights regarding the identification of sustainability-oriented actors suitable for the study. The core of data collection is then represented by in-depth individual and group interviews administered to the leading members of the selected organisations, supported by additional information from supplementary sources.

More precisely, we initially explored the strategic interactions among the circular-oriented entities by conducting four open-ended interviews with managers and leading members of the two focal companies (Company A and Company H) to assess the eligibility of the cases. This preliminary investigation was complemented by performing painstaking exploratory analysis of the relational dynamics established by the two key companies with their respective stakeholders. We designed the interview protocol to be more flexible and open in the first group surveys; while it changed to semi-structured interviews once we had identified the target companies to be studied. This second step involved 16 semi-structured interviews administered to managers and highly informed participants of the organisations involved in the strategic partnership. We included these subjects in the data collection process due to their decision-making role in circular product development and circular process establishment, as output of the inter-organisational collaboration. This approach provided us the opportunity to gather information about the companies' circular practices by keeping the conversation within chosen boundaries while leaving openness for the participants to explore relevant aspects and experiences (Kvale, 1996; Timmermans & Tavory, 2012). We interpreted the data that emerged from the interaction between the interviewers and the interviewees based on our high level of reflexivity and extensive knowledge (Silverman, 2015).

In practice, the interview guide addressed the research questions in the form of a semi-structured conversation (see Table 6 for the detailed interview guide). Overall, we administered a total of 20 open-ended group and individual semi-structured interviews either in person or through virtual meetings from July to December 2022. Each individual or group colloquium lasted between 35 min and 1 hr, and was recorded by mutual consensus of the participants. During the entire

data collection process, we gathered some secondary material from websites, public reports and company communications. In seeking situated explanations, we decided to rely on different sources to analyse information about the two case studies from different points of view and to elaborate on a contextualised explanation of the events (Easton, 2010; Flick, 2004; Lawani, 2021; Welch et al., 2022). Data triangulation allowed us to outline a more detailed view of the structures of the two multi-actor collaborations (e.g. Ranta et al., 2018; Santa-Maria et al., 2022). We deemed data collection to be complete when theoretical saturation was reached (Corbin & Strauss, 2007; Marshall & Rossman, 2014; O'Reilly et al., 2012).

Table 6. Semi-structured interview guide

Questions
1. What does circular economy mean to you? Are you familiar with the circular economy principles? What process or practice have you implemented, or do you plan to implement, in this sense?
2. How did your commitment to the circular economy rise and/or evolve? Did you develop a circular process, product or service? If so, is it a result of product/process innovation?
3. How important are the other actors (e.g., companies, public entities, foundations) in the definition of a circular-oriented innovation that enables the establishment of a circular business?
4. Did you have all the required capabilities, knowledge, and structures internally, as well as access to sensible resources, to launch the circular practice? Or did you experience knowledge and resource channelling/exchanges through the involvement of other actors (e.g., companies, public entities, foundations)?
5. Has this led to the generation of new innovations or knowledge from which all actors have benefited in terms of their approach to the circular economy?
6. From your point of view, what is the advantage of undertaking an open innovation approach to leverage the interactions among different stakeholders in addressing the circular economy transition?
7. Did you recognise any risks associated with the dissemination of internal knowledge to other organisations/realities?

Source: Authors' elaboration.

3.3.3 Data analysis

Before addressing the data analysis process, it is worth mentioning our meticulousness in applying the present methodological approach. Findings' validity and reliability have been ensured by taking some precautions suggested by renowned authors (e.g. Corbin & Strauss, 2007; Gibbert et al., 2008; Marshall & Rossman, 2014). We designed the interview guide by drawing on similar

questionnaires adopted in comparable qualitative empirical analysis in the CE literature (Aranda-Usón et al., 2020; Hofmann & zu Knyphausen-Aufseß, 2022). In addition, we involved the participants in theme validation and interpretation while we interviewed them. The data collection process included a triangulation phase in which we combined empirical observations from the participants with various sources of information (Flick, 2004). This approach ensured better comprehension of the cases, alongside a holistic explanation of the interests that facilitate the interactions that allow companies to build circular-based collaborations (Gibbert et al., 2008; Marshall & Rossman, 2014; Yin, 2014). We also ensured the accuracy of the results with an intercoder comparison and discussion to ensure the accurate interpretation of data. Thus, we addressed intercoder reliability by assessing the agreement of the authors regarding the interpretation of the data collected via multiple sources for the two case studies (O'Connor & Joffe, 2020; Potter & Levine-Donnerstein, 1999; Schwanholz & Leipold, 2020).

While collecting data, we started the systematisation process and analysis of the information gathered from multiple sources. The interviews were transcribed and complemented with field notes and support documents, extracted from websites and company reports. Then, we coded the data and interpreted it based on our experience. As an exploratory qualitative analysis, it was not our intention to look for common patterns among the cases (Bygstad et al., 2016; Ragin, 1992; Silverman, 2015; Welch et al., 2022). Wearing the critical realist lens, we explored the two cases from different actors' perspectives to aggregate each point of view in the respective inter-organisational relational network. In this way, we observed the positioning of the organisation in the circular supply chain and in the circular ecosystem to achieve a more accurate analysis and description of the case from the actors' perspective. To add more value to the data analysis, we sought causality representation of the intertwined set of interactions and interdependencies among the actors, while designing inter-organisational collaboration to induce product or process innovation for circularity (Timmermans & Tavory, 2012; Welch et al., 2022). The two case studies allowed us to unpack the network of relationships and resource exchanges that have contributed to structuring the two collaborative configurations. The data analysis then moved from exploring the two collaborative architectures embedded in their context to their comparison. We performed a cross-case inquiry (e.g. Blomsma et al., 2023; Ranta et al., 2018) to offer commonalities

and differences between the two collaborative approaches in dealing with the CE transition (Piekkari et al., 2009; Yin, 2014).

3.4 Results

The analysis of the case studies allowed us to identify two strategic collaborative approaches to foster CE implementation in companies. In both cases, OI proved to be the key to unlocking CE strategies by embedding upcycling practices in businesses. We present the main findings of our exploratory analysis in the following sub-sections, outlining how a circular supply chain and a circular ecosystem architecture represent empirically validated approaches for businesses to achieve sustainable development by leveraging OI practices.

3.4.1 Circular supply chain for waste as resource

The first case study describes how the establishment of partnerships across the food value chain can boost the adoption of circular practices based on the transformation of waste material into new secondary raw resources. The founding of an innovative start-up (Company A), characterised by the mission to reduce food waste and its environmental impact in the form of lower CO2 emissions, represents a pivotal point in the creation of the circular supply chain. As stated by the chief executive officer (CEO): '*[Company A] was created with the aim of reducing food waste on the planet. Following the principles of circular economy, we established an upcycling process to reintroduce recovered food waste back into the production process'.* Thus, Company A's business model has been built upon the sustainability-oriented objective to coordinate resource recovery from unsold goods and production wastage (i.e. bread, pasta offcuts and exhausted barley malt) to attribute their new value as inputs for other production processes (i.e. beer and snacks). The key element in fostering a circular supply chain lies in the partnership established by the aforementioned innovative start-up with upstream and downstream stakeholders. These include bakeries (such as Company F), HoReCa operators (such as Company E), a pasta manufacturer (Company G), large-scale retail trade operators (such as Company B and Company C) and a small beer producer (Company D) who joined Company A's circular project (see Figure 8).

Through the exploitation of waste-as-resource materials among partners in the food and beverage industry, three main circular processes can be outlined that give rise to as many circular products. By recovering surplus food in the form of bakery

waste from HoReCa operators (such as Company E), bakeries (such as Company F) and large-scale retail trade operators (such as Company B and Company C), suppliers' unsold bread is processed by Company A to obtain barley malt and yeast. Similarly, offcuts from pasta production of Company G are also recovered by Company A as barley malt. These secondary raw resources are employed as inputs for craft beer production, administered in conjunction with the brewing Company D. The latter gives rise to innovative circular products in the form of two kinds of premium craft beers. In this way, there is a reduction in raw materials fed into the production cycle, which corresponds to about one third of the barley malt used in the production of beer, besides the waste reduction in the food industry and its environmental impact. Then, brewing leaves residues in the form of spent barley malt, commonly known as threshing barley. After processing, it is depleted of sugars yet still rich in protein, fibre and mineral salts. The recovery of spent barley malt results in an input material that contributes to the production of another innovative circular product (i.e. a baked snack). As such, scrap from beer production is further processed by Company A to become new input in the production of baked snacks, taken over by the bakery Company F. This approach allows replacing almost half of the virgin raw resources used in snack production, leading to food industry waste reduction and lower emissions, alongside fewer virgin materials entering the production cycle. Finally, the channel to market these circular-based products is facilitated by the downstream stakeholders operating in large-scale distribution (Company B and Company C), besides the e-commerce operated by Company A and other partners that sell the product via their online shops. For example, Company G's online marketplace offers the beer that has been made by employing its pasta offcuts.

Overall, the circular supply chain structure allows scrap collection (i.e. bread, pasta offcuts, and exhausted barley malt) and recovery into higher value secondary raw materials (i.e. barley malt, yeast and spent barley malt containing minerals, fibre and protein), which are then used to realise premium circular products (e.g. craft beers and snacks). While preventing food and beverage industry scraps and food surpluses from being disposed of or sold off as animal feed ingredients, the collaborative effort of multiple companies has enabled innovative circular processes to leverage waste as a resource for circular product development. As a result, the circular supply chain's output is represented by three main offerings that reach the market: two kinds of premium craft beers and baked snacks.

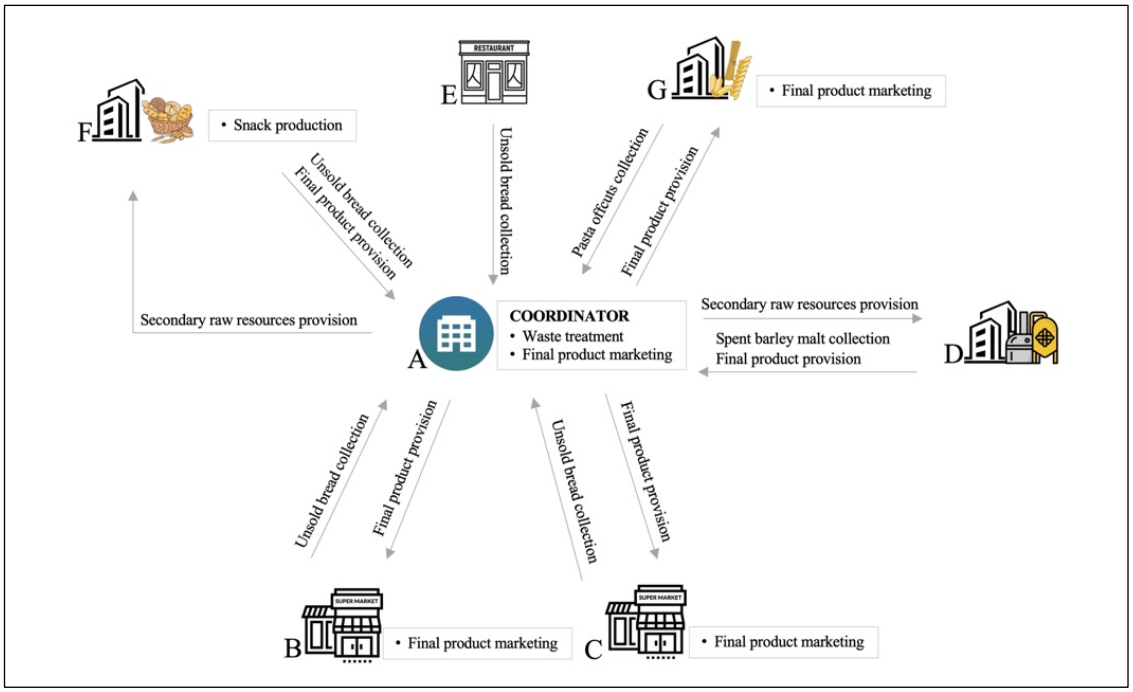
Commitment to corporate sustainability and CE principles has inspired and strengthened the organisations' willingness to build new relationships among one another, yet the main coordinator has been Company A. It is positioned between manufacturers and retailers and has played the role of central coordinator of the circular supply chain as a forward-looking company that recognises opportunities through the CE transition. As a coordinator, Company A has acted as an intermediary among heterogeneous realities by connecting them for the collection, recovery, processing and utilisation of waste as new resources. These partnerships outline flexible, medium-term oriented linkages within the circular supply chain, where the actors create value out of the resources and knowledge gathered to shape circular processes and products. More specifically, we observed how Company A has acted as the central node of the circular supply chain by controlling the flow of resources and knowledge, as well as coordinating activities and the OI strategies in connection with other actors. The exchange has not been limited to the provision of resources and market outlets for circular products. Indeed, the most important element is represented by the knowledge gathered from different actors and conveyed into the development of innovative circular processes and products. In line with the evidence collected from the CEO of Company A, the chief technology officer of Company G and the CEO of Company D agreed that knowledge gathering is a fundamental element to enable circular-oriented innovation: '*we only have a fraction of the know-how required to undertake the upcycling process. Knowledge of an innovative nature meets more technical know-how to build innovation for circular economy'.*

While Company A has dealt with the collection of food waste as the coordinator of the circular supply chain, the processing of the surplus and product development activities has required more technical capabilities. Company A is more familiar with CE principles and CBM innovation, which is the reason why it has acted as a coordinating figure in the circular supply chain. However, purely innovative know-how and awareness of CE principles have been complemented by operational and technical know-how related to material recovery and the development of circular products. The connection among the actors has ensured an exchange of knowledge that has shaped the OI strategy behind upcycling. More precisely, Company A's internal knowledge related to CE has been complemented with knowledge about waste features from bakeries (Company F), HoReCa operators (Company E), the pasta manufacturer Company G and large-scale retail trade operators (Company B

and Company C), besides the expertise offered by the beer producer Company D, to shape an innovative circular process that effectively converts unsold bread into secondary raw material input for beer production. Similarly, Company A has coordinated the knowledge and resource exchange between the pasta manufacturer (Company G) and the beer producer (Company D) to design a feasible circular process that allows pasta offcuts to be recovered into beer production components. In both cases, the actors have taken advantage of inside-out and outside-in OI strategies to gather awareness of circular practices, specific technical know-how related to bread and pasta and technical expertise from the beer producer, to figure out how to leverage waste as new resources. An open collaborative environment has also been the key to recover spent barley malt: Company A has promoted process innovation to treat beer production scrap by drawing on Company D's waste awareness and Company F's experience in developing bakery products. As a result, the strategic alliance has leveraged OI strategies to overcome technical barriers to CE transition to develop circular-oriented innovations aimed at cycling waste from bakery and pasta value chains into secondary raw resources for the beer and baked snack value chains. Therefore, the coupling strategy in an open collaborative environment has favoured the recombination of the companies' internal knowledge with the external expertise and know-how provided by the other actors towards cocreating innovative processes and circular products. Complementary partners have combined inbound and outbound OI strategies with the aim of developing recovery processes to employ waste-as-resource materials in new circular products. In this direction, the CEO of Company A has supported the importance of strategic alliances in achieving circularity: *'If a company wants to achieve circularity, it is essential that there is collaboration with other entities. Synergy among different actors is important, otherwise the circularity discourse in entrepreneurship remains somewhat "crippled", partial, or does not express its full potential'.*

From the insights offered by this case, we can conclude that a circular supply chain formation based on OI practices underpins the effective implementation of CE strategies. It offers the basis for narrowing, slowing and closing the resource loop by recovering waste from a value chain to reduce the resource input of similar value chains.

Figure 8. Graphical representation of the circular supply chain



Source: Authors' elaboration.

3.4.2 A local circular ecosystem for higher quality recovery

The second case study illustrates that five companies operating in different industries, yet belonging to the same local context, have established a circular ecosystem based on waste valorisation with the support of a public entity. More specifically, the companies operating in the food and beverage (Company H and Company L), chemical (Company I), pharmaceutical (Company K) and manufacturing (Company J) domains have succeeded in establishing upcycling practices, also thanks to the joint effort of the local Research Institute M. These sustainability-oriented companies have set up a strategic alliance among private and public entities, arranged according to an interactive and collaborative environment where OI strategies are leveraged to achieve higher quality recovery of industrial waste (see Figure 9).

The CEO of Company H, the leading actor of the circular ecosystem architecture, clearly outlined the underlying purpose of the strategic alliance as follows: *'The circular economy is not just about reducing businesses' environmental impact and achieving zero waste production, but also about leveraging unexploited valuable resources identified in processing steps. These are approaches that are well suited for food companies, as well as for other industries'.* In this vein, the circular ecosystem architecture is based on the optimisation of waste recovery from craft

beer production. Grain and barley malt processing leaves scraps in the form of spent barley malt, from which the brewery extracts starches to provide fermentable sugars for the yeast, but other precious nutrients are still present. While such waste materials are partially absorbed by the animal feed industry, this initiative has pursued extracting nutrients from beer production scraps to take advantage of the residual substances in spent barley malt before being disposed. Hence, recovery processes inspired by the CE principles allow organisations to extract valuable resources from waste, which represents secondary raw materials for the realisation of innovative circular products such as baked goods, beverages with specific features, nutritional supplements and cosmetics.

In practice, Company H deals with the processing of primary goods (i.e. craft beer), producing spent barley malt as production scrap. To extract the residual valuable nutritive elements from such waste, Company J is involved in the transformation of exhausted malt through homogenisation and physical processing into recovered raw material, along with the support of Company I for chemical transformations and technical services. By combining their know-how in food processing and chemical treatments, useful substances—plant-based proteins, nutritional fibres (including arabinoxylans), beta-glucans and a sweetener obtained by refining and condensing water juice derived from beer production (i.e. starch milk)—can be successfully extracted from spent grain. Secondary raw material retrieval is potentially expendable in circular product development, resulting in a reduction in virgin raw material input in business processing. Then, such recovered resources are introduced as input in innovative circular product development by four companies belonging to the circular ecosystem. First, Company H takes advantage of the sweetener recovered from starch milk to realise a sugar-free line of innovative beverages. This company also uses plant-based proteins in the production of non-alcoholic beverages characterised by a high protein levels, while beta-glucans and fibres (i.e. arabinoxylans) are applied to develop innovative non-alcoholic beverages designed to reduce the amount of sugar and cholesterol absorbed by the digestive system and thus cardiovascular disease. Second, Company K employs betaglucans and arabinoxylans to produce nutritional supplements that assist the intestinal microbiome and support the immune system, as well as supplements designed to prevent heart disease and diabetes. As a bakery, Company L benefits from using recovered plant-based proteins to produce functional snacks. The company also uses the sweetening agent as input in sugar-

free festive bakery products for diabetic consumers. In addition to dealing with the chemical treatment of by-products, Company I includes a substance obtained from dried and pulverised spent barley malt as a secondary raw resource in the production of cosmetics (especially hand and body lotions). Acting across the board, Research Institute M conducts the market analysis and consumer investigations that support the circular product design by the companies. As a result, the recovery of nutrients from spent barley malt, before being sold off as food for breeding animals, allows the companies to jointly develop a wide range of innovative circular products (i.e. beverages, nutritional supplements, lotions and baked goods). Such circular products are meant to be sold by their respective manufacturers but, as outputs of the circular ecosystem, the actors' agreement ensures a fair distribution of the value created. In this vein, in addition to being responsible for market analysis to support the development and launch of the new circular products, Research Institute M has been appointed to administer the value creation and delivery link among the partner companies. Therefore, this case depicts how a circular ecosystem architecture allows companies to create shared value from waste recovery and circular product development by leveraging upcycling practices.

The circular ecosystem architecture has enabled collaboration among the stakeholders towards the development of circular processes aimed at recovering valuable resources from waste materials. In this case, Company H represents the outstanding actor that has led the circular transition project by acting as the orchestrator of the strategic alliance. As the circular ecosystem orchestrator, Company H has built trust and commitment among the businesses and entities involved, besides promoting communication among the actors and a shared vision towards win-win-win opportunities related to CE. In this vein, Company H has promoted the inclusion of actors in the ecosystem and their interaction, encouraging and facilitating their exchange of knowledge and resources. The circular ecosystem architecture in this case is characterised by continuous brainstorming among the main figures of the parties involved. Each actor provides unique knowledge and expertise to shape innovative processes, to extract valuable elements from brewing waste, and to outline innovative uses of recovered resources according to their businesses. As stated by the CEO of Company J, in agreement with the CEOs of Company H and Company I, during a group interview with Research Institute M: *'No company has a predefined role. We have different*

backgrounds and expertise, the integration of which allows us to outline viable paths for translating circular principles into feasible processes'.

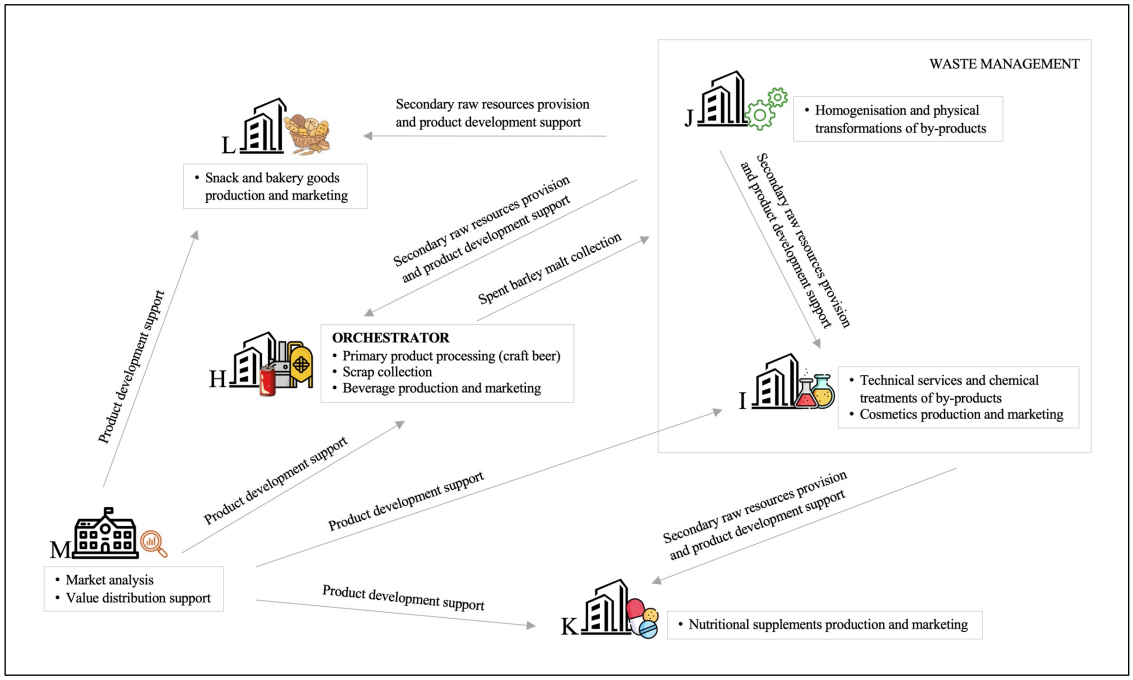
An open environment enables process and product innovation by leveraging a local circular ecosystem architecture, where companies cooperate to reduce virgin material employment and production waste. Awareness of CE practices acts as a guideline for the entire ecosystem, to which the actors from heterogeneous domains have added their specific know-how and technical capabilities. Company G's CEO supports the interaction among the multiple actors in the circular ecosystem architecture: *'The need to bring in multiple and heterogeneous actors results in having more specific expertise. This makes it possible to achieve a circular economy ecosystem that cuts across the value chains of multiple industries'.*

More specifically, a combination of outside-in and inside-out strategies has allowed Company H to share awareness about CE principles and to acquire technical know-how from Company J and Company I to co-develop a circular process to recover residual nutrients from beer production waste. Company H's familiarity with spent barley malt has been complimented by Company J's expertise in dealing with organic products, which in turn has been supplemented by the chemical treatments advanced by Company I. Thus, the companies have been able to conduct tests on the waste elements by using Company J's machinery to jointly define an innovative process capable of extracting the desired resources. As a result, we found that inbound OI strategies are again the key to co-developing innovative circular products from recovered resources. Companies H, I, K and L have come up with product innovations by identifying the applicability of by-products within their specific fields, supported by the market insights offered by Research Institute M. Overall, circular product development has resulted from the specific understanding of beverages, cosmetics, pharmaceutical and bakery markets, besides the waste awareness of Company H and the active support of Company I and Company J that have engaged in input material predisposition for product manufacturing.

This second case also demonstrates that OI has been the key to advancing innovative circular processes to extract nutrients and to design innovative circular products with a reduced environmental footprint. Such OI strategies are part of the circular ecosystem architecture: private and public actors from different industries interact in a vibrant, locally embedded environment to gather resources, know-

how, expertise, technological tools and production facilities and to translate CE principles into long-term sustainable businesses.

Figure 9. Graphical representation of the circular ecosystem architecture



Source: Authors' elaboration.

3.4.3 Cross-case analysis: Outlining commonalities and differences

In sum, our exploration of two inter-organisation collaborative settings has shed light on how companies leverage OI to put CE principles into practice. Both the circular supply chain and the circular ecosystem architecture have taken advantage of inbound and outbound strategies to enable circular business development through upcycling practices. Opening up the innovation process through multi-stakeholder strategic alliances has resulted in a successful approach to overcome technical barriers related to waste material recovery, as well as to design innovative circular products that include secondary raw resources rather than sourcing virgin materials. However, when looking at stakeholders' interactions and the administration of critical resources and knowledge flows, the two collaborative approaches display some commonalities and differences.

While we addressed the development of innovative circular processes and products through the interaction of multiple actors, we found substantially different entities operating within the circular supply chain and the circular ecosystem. The former specifically includes manufacturers and retailers of various sizes that belong to compatible supply chains in the food and beverage domain. In this vein, circular

supply chains seem to be focused on a vertical collaborative setting that leverages the actors' extensive knowledge about the common industry. On the other hand, the circular ecosystem architecture has welcomed companies and a public entity from a wide range of sectors that brought more heterogeneous know-how and expertise into the strategic alliance. Leveraging cross-industry partnerships is a strength in the development of circular processes and products, qualifying the ecosystem as an exchange environment where harnessing profoundly different resources and knowledge provides a source for OI strategies. The pronounced pattern of interaction among the actors has unlocked innovation opportunities in the food and beverage domain, thanks to chemical extraction processes and physical transformation treatments that have enhanced waste recovery. Compared with the circular supply chain, the circular ecosystem architecture is also characterised by the local context where heterogeneous companies and public entities are involved due to their territorial proximity. As a locally embedded circular network, the circular ecosystem architecture demonstrated a more intensive exchange of critical resources and knowledge among the actors, resulting in strengthened OI processes.

Other common elements of the investigated cases include the presence of an outstanding actor, a company that typically holds a central role in the network by acting as a facilitator for stakeholders' interactions and as a catalyst for collaborative ventures. More specifically, we identified these figures as the coordinator of the circular supply chain (i.e. Company A) and an orchestrator of the circular ecosystem architecture (i.e. Company H). In the first case, the activities of the enterprises revolve around a central actor who coordinates the entire circular supply chain. The interactions among stakeholders to define circular processes and products are usually one-on-one, where the coordinator directly interfaces with a downstream or an upstream stakeholder. On the other hand, we found that in the circular ecosystem architecture, there is a stronger involvement of each actor around decision-making and innovation processes. The orchestrator represents a leading actor that fosters trust and commitment among the other entities involved while facilitating stakeholders' interactions without centralising critical resources and knowledge flows.

In addition, we noted an interesting distinction when closely analysing the two collaborative approaches in the distribution of the economic value created by circular businesses. This economic value includes the revenue generated from

selling circular products to consumers, the reduction in virgin raw material inputs into the production process, and the net expenses associated with recovering secondary raw resources and logistics. In the first case, the actors belonging to the circular supply chain are linked by supplier– customer relationships and the distribution of value is based on the trade negotiation of by-products and final goods between the coordinator and the other companies. Considering the collaborative approach based on a circular ecosystem architecture, value distribution relies on an agreement designed to equally share the economic value created from the circular processes. To guarantee the success of this initiative, Research Institute M has been entrusted with administering the economic value allocation among the other economic actors to ensure fair remuneration for engaging in CE practices.

Overall, the cross-case analysis led us to conclude that the circular ecosystem involves greater interaction among stakeholders and a more intensive exchange of resources compared with the circular supply chain. At the same time, the circular ecosystem architecture shows better cohesion and alignment among the actors based on a long-term perspective.

3.5 Discussion and implications

As a result of our exploration of collaborative CBMs, our findings include two comparable collaborative approaches, albeit with some distinguishing elements. In both cases, we observed that the adoption of OI processes has resulted in the integration of CE strategies in businesses. Consistent with previous research that has emphasised the role of OI in fostering business sustainability (e.g. Bogers et al., 2020; Camilleri et al., 2023; Kennedy et al., 2017; Rauter et al., 2019), this study empirically explored inside-out and outside-in strategies as even more important while dealing with circular-oriented innovations. Indeed, the innovations underlying circular products or processes entail several barriers and technical challenges due to waste manipulation for recovery, design and implementation complexities; financial support and market acceptance (Brown et al., 2020; García-Quevedo et al., 2020; Hina et al., 2022; Jaeger & Upadhyay, 2020; Kumar et al., 2019; Urbinati et al., 2021). These issues lead companies to transcend their boundaries and to advance strategic collaborations with other entities to acquire critical resources and knowledge and to foster the implementation of more effective and wide-ranging sustainable practices (Bogers

et al., 2020; Brown et al., 2021; Carraresi & Bröring, 2021; Jabeen et al., 2022). Our findings support that, without embracing collaborative sustainable innovation, it would not have been possible to achieve the same results due to the highly complex and demanding domain. Echoing Appleyard and Chesbrough (2017) and Bogers et al. (2017), CBMs benefit from collaborative innovations to enhance their knowledge flows, besides accessing critical resources or new markets as suggested by Brown et al. (2019) and Bocken and Ritala (2021).

Following the literature reviews by Jesus and Jugend (2023) and Suchek et al. (2021), where the authors highlighted the link between OI and CE, our exploratory multiple case study complements Köhler et al. (2022) in depicting a cross-supply chain and cross-sectoral collaboration as instrumental in putting upcycling strategies into practice. More specifically, we focused on stakeholders' interactions and their collaborative mechanisms to promote innovative circular processes and products (Mishra et al., 2019; Zucchella & Previtali, 2019), according to two different collaborative approaches. Drawing on previous studies that advanced the concept of a circular supply chain (e.g. Aarikka-Stenroos et al., 2022; Bressanelli et al., 2019; Farooque et al., 2019; Kusumowardani et al., 2022), our results concur in outlining its characteristics and how it can lead to the development of collaborative CBMs. The circular supply chain has proved to be a strategic approach where companies advance cross-supply chain collaboration within a specific industry. As a result, this collaborative approach has successfully supported OI strategies by leveraging industry-specific knowledge to take advantage of waste as resource in premium circular product processing (Ellen MacArthur Foundation, 2013; Geissdoerfer et al., 2020; van Hal et al., 2019). On the other hand, our findings from the second case study supplement previous studies that have presented circular ecosystems as more participatory and interactive collaborative approaches, which involve heterogeneous actors from various sectors (e.g. Bertassini et al., 2021; Kanda et al., 2021; Konietzko et al., 2020; Zucchella & Previtali, 2019). In contrast to the circular supply chain formation, the IO processes are more intensive and have allowed the actors to leverage knowledge from the chemical and manufacturing fields to support the recovery and use of by-products in the food and beverage domain (Moggi & Dameri, 2021; Tapaninaho & Heikkinen, 2022). This implies a greater orchestration effort, as well as the need for a more structured scheme for value creation and distribution strategies (Bertassini et al., 2021; Parida et al., 2019;

Zucchella & Previtali, 2019). Furthermore, the circular ecosystem architecture has leveraged the territorial proximity of the actors to support their interaction and exchange of critical resources and knowledge (Moggi & Dameri, 2021).

Additionally, our findings highlight the importance of outstanding actors in circular networks. The observation of the coordinator and orchestrator roles provided valuable insights into their distinct functions and contributions to fostering collaborative CBMs. These companies, which hold a central role in collaborative CBMs, act as a catalyst for stakeholders' interactions and facilitate the flow of essential resources and knowledge. In this vein, circular supply chain coordinators and circular ecosystem architecture orchestrators are fundamental in leveraging OI mechanisms for collaborative CBM development. In the context of circular supply chains, the coordinator mainly operates within a focused, industry-specific domain. This role primarily revolves around integrating and managing interactions among stakeholders within the supply chain. In this vein, coordinators facilitate resource flow, knowledge exchange and market access, playing a pivotal role in aligning efforts towards circularity. Their influence lies in administering inter-organisational exchanges, optimising material utilisation and streamlining processes to reduce waste generation while promoting the circular use of resources. As a result, we supplement previous studies such as Carraresi and Bröring (2021) and Hansen and Revellio (2020) by outlining some characteristics of focal actors in circular supply chains. On the other hand, the orchestrator of a circular ecosystem architecture operates in a more expansive, cross-sectoral landscape. Orchestrators function beyond industry boundaries, encouraging collaboration among diverse stakeholders from various sectors. They focus on fostering trust, enabling open communication and facilitating collective decision making among heterogeneous entities. Orchestrators are pivotal in ensuring fair resource distribution, promoting equitable value sharing and creating an environment that encourages multi-industry innovation and sustainable practices. Based on previous studies that recognised the presence of a focal actor in circular ecosystems (e.g. Ferrari et al., 2023; Parida et al., 2019; Trevisan et al., 2022; Zucchella & Previtali, 2019), we have enriched the knowledge about the role of the orchestrator figure in circular ecosystems. Overall, these findings contribute to understanding the diverse roles played by coordinators in supply chains and orchestrators in ecosystems, shedding light on their unique functions and behaviours in driving collaborative networks towards the CE transition.

In the following subsections, we summarise the theoretical contributions and managerial implications of this study.

3.5.1 Theoretical contributions

Building on the resource-based view perspective (Barney, 1991, 2010; Grant, 1991; Sehnem et al., 2022), we illustrated through two collaborative approaches how different organisations leverage rare and valuable resources and critical knowledge to achieve circular-oriented innovations. Complementing previous studies (e.g. Chaudhuri et al., 2022; Farooque et al., 2022; Kusumowardani et al., 2022; Muench et al., 2022; Schmidt et al., 2021), our research emphasises the significance of internal and external resource employment in CBMs, as well as the assimilation of diverse expertise across industries, as fundamental drivers in creating and sustaining competitive advantage within the realm of CE initiatives. Specifically, we contribute to theory by showcasing the intricate interplay between resources and knowledge in collaborative networks in addressing barriers to the CE transition. In alignment with the principles of the resource-based view theory, these collaborative endeavours elucidate the importance of unique and non-substitutable resources such as specialised knowledge of waste treatment processes, technological capabilities for material recovery and cross-industry expertise in driving circular-oriented innovations.

Moreover, the integration of such resources and knowledge in collaborative CBMs contributes to enriching the stakeholder theory applied in the business ethics domain (Freeman, 1994; Parmar et al., 2010; Tapaninaho & Heikkinen, 2022), which frames multiple interconnected entities collaborating to create and deliver value across economic, social and environmental value (Freudenreich et al., 2020). The empirical evidence from our study aligns with the fundamental tenets of stakeholder theory (Freeman, 2010; Freeman et al., 2010) by illustrating the intricate relationships and interactions among various stakeholders in both the circular supply chain and the circular ecosystem architecture. Our findings emphasise that the successful implementation of circular-oriented innovations is contingent upon not only acquiring critical resources and knowledge but also promoting robust relationships and collaborations among stakeholders (Moggi & Dameri, 2021; Tapaninaho & Heikkinen, 2022). In the examined cases, the central figures demonstrate how stakeholder relationships and inclusive collaboration serve as catalysts for achieving shared goals and value creation. The stakeholder

theory lens also enhances our understanding of these collaborative endeavours by highlighting the importance of equitable value distribution and fair remuneration among the stakeholders, with particular reference to the circular ecosystem. In essence, our study underlines how the integration of diverse stakeholders, their resources and knowledge in collaborative endeavours not only drives circular-oriented innovation but also fosters sustainable value creation across multiple dimensions.

Drawing on these theoretical milestones, we enrich the literature regarding eco-innovation (Chesbrough & Di Minin, 2014; Cillo et al., 2019; de Jesus & Mendonça, 2018; Ghisetti et al., 2015) at the intersection of CE and OI (Bocken & Ritala, 2021; Jesus & Jugend, 2023; Köhler et al., 2022; Suchek et al., 2021). Our exploratory multiple case study contributes to depicting how OI strategies foster collaborative CBMs, specifically focusing on stakeholders' collaboration mechanisms and critical resources and knowledge exchange to co-develop circular-oriented innovations (Brown et al., 2020; Konietzko et al., 2020). Besides, we emphasise the importance of cross-supply chain and cross-industry strategic alliances in further enhancing the effectiveness of OI practices in collaborative CBMs (Bertassini et al., 2021; Moggi & Dameri, 2021; Tapaninaho & Heikkinen, 2022). As the first empirical study that has compared a circular supply chain and a circular ecosystem architecture, we also managed to highlight the commonalities and differences between collaborative approaches to stimulate new contributions in this regard. In addition, we advocate a new taxonomy for focal actors in circular networks (Carraresi & Bröring, 2021; Hansen & Revellio, 2020; Parida et al., 2019; Zucchella & Previtali, 2019).

3.5.2 Practical implications

From a practical standpoint, this study offers valuable insights for chief sustainability officers and general managers of sustainability-oriented companies. Although this research deals specifically with the food and beverage industry, the lessons learned from the empirical investigation can be adopted analogously in other domains. Such guidance is meaningful in steering organisations towards adopting CE practices that not only minimise environmental impact but also foster a circular, restorative approach in their production systems.

Overall, this study provides valuable insights into how companies can successfully implement CE practices and establish CBMs by leveraging strategic

collaborations. Both case studies highlight the significance of OI in fostering CE strategies; thus, managers should focus on creating an environment that encourages collaboration and the sharing of knowledge and resources beyond organisational boundaries. In this sense, we suggest engaging in strategic alliances to capitalise on external critical resources, know-how, expertise and capabilities, as well as to provide internal knowledge to co-develop circular processes and products. As a result, the adoption of OI practices can effectively mitigate barriers to CE transition by enabling collaborative problem solving to overcome technical issues, reducing costs and risk in R&D processes, accessing a wide range of expertise from various sectors and disciplines, enhancing resource efficiency and creating new market opportunities.

Then, this study highlights how the adoption of collaborative approaches, such as a circular supply chain or a circular ecosystem architecture, can further intensify OI mechanisms. The first case study emphasises the importance of building partnerships across the value chain. Accordingly, managers should seek to establish relationships with upstream and downstream stakeholders, focusing on waste reduction and resource recovery. On the other hand, the second case highlights the benefits of forming circular ecosystems involving public entities and private organisations from multiple industries. We specifically recommend managers look beyond their immediate industry and consider cross-sector collaborations to create innovative circular solutions. This approach can lead to the development of unique products and services while maximising resource efficiency. Particularly concerning the circular ecosystem architecture, companies should consider interacting with local actors and institutions to leverage close connections for creating more effective CE practices.

As the presence of a focal actor proved to be crucial in developing collaborative CBMs, managers can also take inspiration from this study and strive to make their companies a central figure in the circular network. Otherwise, they are recommended to endeavour to establish strong relationships with the actors recognised as coordinators or orchestrators of the circular network.

In conclusion, an interesting aspect of these cases is how they handle the distribution of economic value created from circular processes. Managers should monitor value creation from CE practices and consider how such value is shared among stakeholders, ensuring fair and equitable distribution to maintain long-term partnerships.

3.6 Conclusions and future avenues

In summary, we adopted a multiple case study methodology to investigate how CE practices can be fostered by OI strategies. We explored two collaborative approaches, both dealing with waste recovery and secondary raw resource inclusion in innovative circular products. Through our analysis, we have shed light on a circular supply chain and a circular ecosystem architecture by outlining their commonalities and differences as collaborative CBMs.

Despite our firm commitment to ensuring the rigour of our research, we must highlight some limitations. The first one is represented by the small number of cases. Although our findings are not necessarily generalisable, in line with our critical realist philosophical positioning, we intended to prioritise a deep exploration of the two cases containing multiple observable entities. In response, future studies could further extend the investigation of these collaborative approaches to assess OI's role in fostering business circularity based on a larger sample. Another notable limitation lies in the absence of detailed industrial accounts from the observed cases. Future research would benefit from exploring the distribution of value among the various actors involved in these circular networks. Such an investigation could reveal insights into which participants gain the most benefits from circular-oriented innovations, providing a clearer understanding of the economic dynamics within circular networks. Moreover, delving into the dark side of circular practices in companies and circular networks could provide an interesting perspective for future research. Sustainability is commonly seen as a positive concept in the business management domain, due to the ‘naturalisation’ of the phenomenon in companies (Adler et al., 2007, p. 126). Thus, future studies could deal with the other side of the coin by investigating the effective economic and environmental sustainability of upcycling processes through complex and extremely elaborate circular practices for waste recovery.

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CHAPTER FOUR

Investigating digital technologies' implementation in circular businesses: evidence from the going circular path[3]

Abstract

This research aims to unpack how digital technologies can facilitate the flourishing of circular business practices in small- and medium-sized enterprises by structuring a detailed *going circular path* that explains businesses' evolution toward circularity. In doing so, it outlines how the observed organizations have adopted – or are adopting – circular economy principles thanks to business digitalization. Following an inductive approach based on a multiple case study methodology, we investigated 16 small- and medium-sized enterprises operating in industries that put considerable pressure on the environment (e.g., manufacturing, chemical, construction, fashion, food, and beverage). Our findings confirm how digital technologies, as well as Industry 4.0 structures, play a fundamental role in *shaping, enabling, enhancing*, and *refining* circular products and processes development. Accordingly, we outline a generalizable step-by-step process to pursue circular economy by employing digital technologies. The present study represents a practical handout for guiding companies through their going circular path.

Keywords: *circular economy, circular business model, digitalization, Industry 4.0, digital technologies, SMEs, going circular path*

4.1 Introduction

The grand challenges to achieving a sustainable future encompass complex and interconnected issues that pose significant obstacles to businesses. These challenges often require global cooperation, interdisciplinary approaches, and innovative solutions to deal with climate change, carbon neutrality, biodiversity loss, sustainable resource and waste management, environment conservation, food security and sustainable agriculture, and people's health and well-being (Dzhengiz, Miller, Ovaska, & Patala, 2023; Howard-Grenville, Davis, Dyllick, Miller, Thau,

[3] Perotti, F. A., Dhir, A., Ferraris, A., & Kliestik, T. (2023). Investigating digital technologies' implementation in circular businesses: Evidence from the going circular path. *Journal of Management & Organization*, 1-31.

& Tsui, 2019; Popkova, De Bernardi, Tyurina, & Sergi, 2022; United Nations, 2021). In pursuing a renewable production and consumption system, the circular economy (CE) approach has prompted considerable debate among researchers and practitioners about the fundamental role of businesses in driving environmental preservation and social well-being. It falls among the strategic initiatives that economic organizations can implement to promote corporate sustainability according to the broader economic, environmental, and social interpretation of the triple bottom line suggested by Elkington and Rowlands (1999). More specifically, CE in business management refers to the adoption of practices aimed at maximizing the efficient use of resources, minimizing waste and pollution, and supporting the regeneration of the natural environment (Antikainen & Valkokari, 2016; Centobelli, Cerchione, Chiaroni, Del Vecchio, & Urbinati, 2020; Ellen MacArthur Foundation, 2013; Salvador, Barros, da Luz, Piekarski, & de Francisco, 2020).

The sustainability challenge has increasingly seen the commitment of businesses and consumers (Frey, Bar Am, Doshi, Malik, & Noble, 2023; KPMG, 2020; McKinsey & Company, 2022; Winston, 2022). Indeed, more and more companies are gradually translating their sustainability goals into business practices by giving rise to circular business models (CBMs), yet the harsh reality proves that what has been done is not enough (Aranda-Usón, Portillo-Tarragona, Scarpellini, & Llena-Macarulla, 2020; Bocken, De Pauw, Bakker, & Van Der Grinten, 2016; Geissdoerfer, Pieroni, Pigosso, & Soufani, 2020; Ranta, Aarikka-Stenroos, & Mäkinen, 2018). Despite the visible effort of policymakers, academics, and managers, the world's economy is currently just 7.2% circular and, while this value is supposed to double by 2032 to avoid climate breakdown, it has even decreased in recent years. It means the global economy is still heavily relying on virgin materials extracted from the environment (Circle Economy, 2023; European Commission, 2020a; Pizzi, Caputo, Corvino, & Venturelli, 2020; United Nations, 2021). Although companies around the world are taking their first steps toward a regenerative production system, there is still a long and impervious road ahead. Countless challenges and opportunities stand in front of academia and businesses, including the chance to boost this sustainable shift by surfing the wave of digital transformation.

Among other drivers, the literature has highlighted digital transformation as having a critical role in supporting business sustainability and, more specifically,

circularity (Biondi, Iraldo, & Meredith, 2002; Hina, Chauhan, Kaur, Kraus, & Dhir, 2022; Khan, Razzaq, Yu, & Miller, 2021; Kristoffersen, Blomsma, Mikalef, & Li, 2020; Liu, Trevisan, Yang, & Mascarenhas, 2022; Popkova et al., 2022). Digital technologies have proved to be crucial for transitioning from a linear to a more circular production, with demonstrably positive impacts on both the environment and the economy (European Commission, 2021; Pizzi, Corbo, & Caputo, 2021; Ranta, Aarikka-Stenroos, & Väisänen, 2021). Digital technologies can support companies in going circular by transforming CE principles into feasible activities (Chauhan, Parida, & Dhir, 2022; European Commission, 2023; Kerin & Pham, 2019; Pizzi, Leopizzi, & Caputo, 2021; Rusch, Schoğ gl, & Baumgartner, 2022). In practice, digital platforms can facilitate the exchange of resources, materials, and waste, enabling circular businesses to find new avenues for reuse, recovery, remanufacture, or recycling (Chauhan, Parida, & Dhir, 2022; Pizzi, Leopizzi, & Caputo, 2021). The Internet of Things (IoT) and sensor technologies for process monitoring, alongside additive manufacturing, work to improve resource efficiency while reducing negative externalities related to production and consumption activities (Centobelli et al., 2020; Gebhardt, Kopyto, Birkel, & Hartmann, 2022; Kerin & Pham, 2019). In addition, big data analytics and artificial intelligence (AI) provide insights into lifecycle assessments and support decision-making in circular businesses, analyzing large data sets filled with information related to material inputs, energy consumption, emissions, and waste generation (Bag, Pretorius, Gupta, & Dwivedi, 2021; Liu et al., 2022). Looking at the virtuous examples of well-known companies, the furniture retailer IKEA has embraced digital technologies to support circularity by launching its "Sell-Back Program," which enables customers to sell their used IKEA furniture back to the company in order for it to be refurbished and resold as second-hand items, thereby promoting resource efficiency and waste reduction (IKEA, 2023). Intuitively, the interplay of digitization and CE can also be observed in platform businesses such as Too Good To Go. This digital platform operating in several European countries aims to reduce food waste by connecting end consumers with restaurants, grocery stores, and food suppliers that offer surplus food at discounted prices before it goes to waste (Too Good To Go, 2022; Vo-Thanh et al., 2021). The Italian multinational energy company Enel also offers an inspiring perspective on how to implement digital solutions to optimize energy management and support renewable energy integration. Thanks to advanced data analytics and IoT technologies, the company can monitor and control energy consumption, improve

grid efficiency, and enable the integration of renewable energy sources into the power system (Enel, 2023).

As the establishment of circular practices represent a disruptive change in production and consumption models, this process (supported by digital technologies) is typically addressed in circumscribed agile environments or ambidextrous formations (Bresciani, Ferraris, & Del Giudice, 2018; Chaudhuri, Subramanian, & Dora, 2022; Rialti, Zollo, Ferraris, & Alon, 2019; Shams, Vrontis, Belyaeva, Ferraris, & Czinkota, 2021). In this regard, small- and medium-sized enterprises (SMEs) offer an interesting point of view due to their fluidity and predisposition toward digitalization and sustainability, as well as their contribution to global production (Bartolacci, Caputo, & Soverchia, 2020; Dey, Malesios, Chowdhury, Saha, Budhwar, & De, 2022; Marrucci, Rialti, & Balzano, 2023; Santa-Maria, Vermeulen, & Baumgartner, 2022; Troise, Corvello, Ghobadian, & O'Regan, 2022). They represent 99.8% of economic organizations in Europe, which account for 53% of the whole industrial production, yet we still ignore many aspects of their approach to CE (European Commission, 2021). Previous studies on SMEs highlight how Industry 4.0 and digital technologies tend to favor the integration of CE practices (Ghobakhloo, 2020; Liu et al., 2022; Pizzi, Corbo, & Caputo, 2021), which suggests that digital platforms' have a role in supporting companies' transition to a CBM (Pizzi, Leopizzi, & Caputo, 2021) and that digital capabilities can provide more value to customers alongside CE (Chaudhuri, Subramanian, & Dora, 2022; Fernandez-Vidal, Perotti, Gonzalez, & Gasco, 2022).

Although digitization in CBMs is a rather debated issue, earlier studies have pointed to a lack of guidance in terms of leveraging digital technologies to improve business circularity (e.g., Kristoffersen et al., 2020; Neri et al., 2023). Chauhan, Parida, and Dhir (2022, p. 13) also echoed how "we have been lacking insights into the specific application of digital technologies for CE adoption." In this vein, to support the diffusion of sustainable practices among economic organizations, an in-depth exploration of agile entities is required to wisely address analogous situations and encourage SMEs to move toward a CE (Dalton, 2020; Dey et al., 2022; Zhu, Nguyen, Siri, & Malik, 2022). Crucially, a deep investigation that describes the SMEs' progression path through the implementation of key digital technologies to foster circularity is missing. Such an inquiry would offer new insights into the integration of different digital supports in circular businesses, illustrating how each stage of circular practice's development may require a

specific job to be done in terms of a business' digital integration. Accordingly, this study is based on the following research question: *what is the role of digital technologies in effectively fostering business circularity in SMEs?*

In response, this study aims to unveil how digital technologies adoption can encourage the flourishing of CBMs in SMEs through a detailed *going circular path* that encompasses each business' dynamic evolution toward circularity. Structured as a qualitative empirical paper, abductive reasoning has been employed to investigate 16 businesses via a multiple case study analysis according to Eisenhardt's (1989) and Yin's (2003) recommendations (Piekkari, Welch, & Paavilainen, 2009; Timmermans & Tavory, 2012). Given the positivist philosophical tradition drawn from Eisenhardt (1989), we decided to investigate the advanced research question through a grounded theory approach (Corbin & Strauss, 2007; Glaser & Strauss, 2017; O'Reilly, Paper, & Marx, 2012). The present research builds on institutional theory to explore companies' isomorphism in adopting digital technologies to achieve circularity (Carmona-Márquez, Leal-Rodríguez, Leal-Millán, & Vázquez-Sánchez, 2022; DiMaggio & Powell, 1983; Do, Mishra, Colicchia, Creazza, & Ramudhin, 2022; Haunschild & Miner, 1997; Meherishi, Narayana, & Ranjani, 2019; Meyer & Rowan, 1977).

Through the observation of how business digitalization can foster the implementation of circular practices in SMEs, this research provides important insights to promote CE adoption in businesses and (hopefully) the further closing of the circularity gap over time, thereby addressing the UN's Sustainable Development Goals (Circle Economy, 2023; Dantas, De-souza, Destro, Hammes, Rodriguez, & Soares, 2021; Macht, Chapman, & Fitzgerald, 2020; Pizzi et al., 2020; United Nations, 2021). Thus, the contribution of our research is threefold: (a) it offers a more detailed scheme of circular business evolution in SMEs through a replicable step-by-step process; (b) it expands the CE literature by highlighting the four roles of digital technologies in circular businesses according to each step of the *going circular path*; and (c) it contributes to the integration of institutional theory in the CE domain by observing circular businesses' isomorphism in adopting digital technologies to achieve a higher level of circularity. In addition, our findings offer some practical implications for managers, specifically chief sustainability officers and sustainability specialists, in the form of recommendations on how to make the best use of digital technologies with respect to a company's circular business evolution.

Following this introduction, a brief literature review aimed at supporting the research question around which the paper has been built is provided. Then, the next two sections present the research design and the results of the multiple case study analysis. The manuscript concludes with a comprehensive discussion of our findings, followed by some concise reflections.

4.2 Theoretical background

4.2.1 Circular economy: outlining circular businesses

The concept of CE, which has arisen as a sustainable alternative to linear production systems, is prompting more and more interest in the scientific debate, as well as in everyday business realities and governments around the world (European Commission, Directorate-General for Environment, 2020a; Hina, Chauhan, Sharma, & Dhir, 2023; Murray, Skene, & Haynes, 2017; United Nations, 2021). CE offers a response to the limitations and negative impacts of the traditional linear economy, commonly described by reference to the sequence 'take, make, use, and dispose,' which emphasizes raw materials collection and transformation into marketable products meant to be ultimately discarded as waste. In contrast, a CE involves an imperative transition toward a new production and consumption paradigm in favor of environmental preservation and people's wellbeing (Bocken et al., 2016; Centobelli, Cerchione, Esposito, & Passaro, 2021; Circle Economy, 2023; Franzò, Urbinati, Chiaroni, & Chiesa, 2021). CE provides insights into a business strategy that companies can implement to promote corporate sustainability as a specific set of practices intended to address resource efficiency and waste reduction. The understanding of sustainability intuitively refers to the interpretation advanced by Elkington and Rowlands (1999) of the 'triple bottom line,' consisting of economic, social, and environmental perspectives. In a nutshell, this sustainable approach is based on a restorative and regenerative system where resources, energy consumption, and waste are minimized throughout the production and consumption stages (Antikainen & Valkokari, 2016; De Bernardi, Bertello, & Forliano, 2023; Ellen MacArthur Foundation, 2013; Geissdoerfer et al., 2020; Hopkinson, Zils, Hawkins, & Roper, 2018).

A CE approach is based on sustainable opportunities, where forward-looking businesses undertake a circular transition pursuing sustainable value creation, delivery, and capture (Averina, Frishammar, & Parida, 2022; Centobelli et al.,

2020; Khan, Daddi, & Iraldo, 2020). Taking an idea or hunch about the redefinition of a product, practice or process, sustainability-sensitive companies implement business strategies designed to redefine their business model. According to CE principles, an increasing number of companies are reshaping their business models with processes and outputs based on common initiatives. Drawing on Bocken et al. (2016) and Geissdoerfer, Morioka, de Carvalho, and Evans (2018), CBMs can be defined as specific sustainability-driven business models predicated on slowing, closing, and narrowing resource and energy flows (Salvador et al., 2020). A circular approach complies with the 'cradle-to-cradle' economy advanced by McDonough and Braungart (2010), where materials and resources are included in a circular process of reemployment within a closed loop system (Franzò et al., 2021; Lüdeke-Freund, Gold, & Bocken, 2019; Stahel, 2010). Thus, a circular business is firstly characterized by its effort in extending or intensifying its products' fruition period through long-lasting design, reuse, repair, or remanufacturing practices aimed at slowing down the flow of resources (e.g., Hopkinson et al., 2018; Khan et al., 2021). Geissdoerfer et al. (2018) further emphasized the role of slowing practices in a circular business such as intensifying the use of products or dematerializing physical assets thanks to digital technologies and services. When the lifespan of a product comes to an end, as in the case of waste from the production process, the resource loop needs to be closed, aligning post-use scraps with a new production cycle. Consequently, CBMs involve recycling practices to minimize waste and enhance material and resource recovery in a regenerative cycle of production and consumption (e.g., Chaudhuri, Subramanian, & Dora, 2022; Wilts, Garcia, Garlito, Gómez, & Prieto, 2021). A third typical strategic approach that identifies circular-committed companies also concerns the reduction of resources' flow in production processes to promote energy and material efficiency by virtue of a responsible allocation of production inputs (e.g., Dantas et al., 2021; Franzò et al., 2021). As Bocken et al. (2016, p. 310) point out, the latest approach differs from slowing and closing strategies 'as it does not influence the speed of the flow of products and does not involve any service loops,' yet narrowing the resource loop plays a fundamental role in circular businesses. Although it was already in place in some realities' linear systems, recent studies reveal how this component is further emphasized and has acquired a fundamental role in pursuing input optimization for cleaner production and consumption (Gallego-Schmid, Chen, Sharmina, & Mendoza, 2020; Ranta, Aarikka-Stenroos, & Väisänen, 2021). Overall, these circular approaches allow

organizations to undertake a closed-loop system through the rethinking of products and processes to maximize the life of goods, enhance waste recycling, and make efficient use of resources (Antikainen & Valkokari, 2016; Ellen MacArthur Foundation, 2013; Geissdoerfer et al., 2018). Specifically, common practices in CBMs involve activities such as reducing resource input or waste generation, durable product design and repair, reusing goods for the same original purpose, recovering materials or energy, remanufacturing products and components for new use, and recycling to convert waste into new resources (Ellen MacArthur Foundation, 2013; Geissdoerfer, Savaget, Bocken & Hultink, 2017; Lüdeke-Freund et al., 2019).

4.2.2 Digital technologies and Industry 4.0 for business circularity

Given that considerable number of studies have offered a conceptualization of CE practices within CBMs (e.g., Antikainen & Valkokari, 2016; Bocken et al., 2016; Geissdoerfer et al., 2018; Lüdeke-Freund et al., 2019), in recent years, researchers and practitioners have demonstrated a growing interest in the adoption of digital technologies alongside these peculiar sustainable business models (e.g., Chauhan, Parida, & Dhir, 2022; Dantas et al., 2021; Gebhardt et al., 2022; Hina et al., 2022; Khan et al., 2021; Liu et al., 2022; Neri et al., 2023; Ranta, Aarikka-Stenroos, & Väisänen, 2021). We refer to digital transformation as a groundbreaking process that involves the integration of digital supports into various aspects of an organization to redefine business processes, deliver value to customers, and create new business models (Fernandez-Vidal et al., 2022; Vial, 2019). More specifically, we also identify Industry 4.0 as a digital revolution of manufacturing processes, wherein digital technologies, such as cyber-physical systems, IoT, AI, and big data analytics are employed to create highly connected and automated production environments (Gebhardt et al., 2022; Kerin & Pham, 2019). Indeed, the wave of Industry 4.0 and digitalization represent a radical change for every business (Bresciani, Ferraris, Romano & Santoro, 2021; Ranta, Aarikka-Stenroos, & Väisänen, 2021), including CBMs. In this vein, digital technologies support the translation of CE principles into feasible activities that optimize and empower circular practices by improving their positive impact or reducing their negative externalities (Gebhardt et al., 2022; Ghobakhloo, 2020; Kristoffersen et al., 2020; Liu et al., 2022; Pizzi, Leopizzi, & Caputo, 2021). Chauhan, Parida, and Dhir (2022) inspected the link between CE and digital technologies in their literature review, highlighting how AI, blockchain, and big data can support management

decisions in circular businesses and the establishment of a CE ecosystem. The study advance by Liu et al. (2022) also strengthened the relationship between these two spheres, outlining seven main mechanisms of digital functions based on automation, data analysis, data collection, and integration, which can enhance CE strategies. Rusch, Schoğgl, and Baumgartner (2022) confirmed the role played by IoT, AI, big data analytics, and blockchain technologies in enabling CE strategies alongside sustainable product management activities. AI in association with digital systems can provide support to implement CE practices, for instance, by allowing recycling and remanufacturing through automatic waste recognition as described by Wilts et al. (2021). Drawing from earlier studies about digital technologies' impact on circular practices, Kerin and Pham (2019) observed how IoT, virtual reality, and augmented reality support the remanufacturing process in economic organizations. Utilizing a case study investigation, Gupta, Chen, Hazen, Kaur, and Gonzalez (2019) questioned big data analytics in data-driven decision-making in supply chain networks, where the improved interaction of members was shown to positively affect CE implementation. Jabbour, Jabbour, Sarkis, and Godinho Filho (2019) also supported digital technologies' virtue of leveraging large-scale data to enhance stakeholders' management of circular businesses. Industry 4.0 technologies thus enable collaboration in circular supply chains and circular ecosystems by fostering mechanisms, such as information sharing, joint planning, and decision-making thanks to IoT technologies, cloud systems, and the blockchain (Gebhardt et al., 2022). Coherently, Khan et al. (2021) deepened the understanding of Industry 4.0-related blockchain technologies adoption in circular businesses, demonstrating a positive effect on the circular practices of smart contracts and transparent information sharing with stakeholders along the supply chain. Besides, even organizational performance has been shown to be enhanced by reinforced circular practices. In SMEs, digital platforms have been observed as valuable tools to establish entrepreneurial ecosystems and enable the transition to a CE (Chaudhuri, Subramanian, & Dora, 2022; Pizzi, Leopizzi, & Caputo, 2021). In terms of business model innovation, Ranta, Aarikka-Stenroos, and Väisänen et al. (2021) explored resource flow reviewing alongside value creation and capture improvements catalyzed by digitalization. The value of data is emphasized through data collection, integration, and analysis processes considered radical or incremental business model changes by virtue of the adoption of CE strategies. For instance, digitalized sectors such as fintech also show a close connection between Industry 4.0 technologies and SMEs' circular transition, which has resulted in the

improvement of CE practices and processes through the integration of fintech technologies (Pizzi, Corbo, & Caputo, 2021).

Overall, our literature review highlights how digital technologies have been recognized for their importance in driving CE adoption in businesses. Big data analytics, AI and machine learning, process automation, blockchain technology, additive manufacturing, IoT, and digital platforms are some examples of the rich set of tools that revolve around data collection and processing to allow more automated and efficient practices according to a renewable production and consumption system (Chauhan, Parida, & Dhir, 2022; Khan et al., 2021; Liu et al., 2022; Rejeb, Suhaiza, Rejeb, Seuring & Treiblmaier, 2022). The relationship between these two spheres (i.e., CE and digital transformation) collides with economic organizations' reality by facilitating their circular transition. However, only a few studies have empirically addressed the effective role of digital technologies in circular businesses, leaving a significant gap regarding their actual adoption and consequences (Chauhan, Parida, & Dhir, 2022; Hina et al., 2022; Liu et al., 2022; Neri et al., 2023). In particular, what is missing in the CE literature is a closer and more critical look at the way companies make use of digital tools during the planning, establishment, and growth of circular businesses.

4.2.3 Explaining circular transition through institutional theory

Through the lenses offered by institutional theory, it is possible to explain companies' isomorphism in adopting CE principles based on sociological and economic mechanisms (DiMaggio & Powell, 1983; Haunschild & Miner, 1997; Meyer & Rowan, 1977). Previous studies have supported how organizations' conversion toward a circular business can be understood as a reasonable reaction to deal with uncertainties by adapting themselves in the manner of counterparts perceived as rational, legitimate, or successful (e.g., Do et al., 2022; Jain, Panda & Choudhary, 2020; Meherishi, Narayana, & Ranjani, 2019; Ranta, Aarikka-Stenroos, Ritala & Mäkinen, 2018). According to the extended institutional theory, companies' practices and decision-making are affected by external sociological and economic variants that involve some mechanisms for legitimacy and efficiency-seeking to cope with uncertainty. Drawing on DiMaggio and Powell (1983, pp. 150–151) and Meyer and Rowan (1977), businesses' adaptive processes toward legitimacy achievement involve three mechanisms: (a) the 'formal and informal pressures exerted on organizations by other organizations upon which

they are dependent and by cultural expectations in the society within which organizations function' (i.e., coercive pressure); (b) the isomorphism deriving from companies' attempts to 'model themselves on other organizations' to deal with uncertainties or due to ambiguous objectives (i.e., mimetic pressure); and (c) the pressure on professionals' homogeneity across organizations based on social norms and cultural characteristics (i.e., normative pressure). Therefore, the exploitation of sustainable opportunities by economic organizations may be observed as an isomorphic attempt to deal with uncertainties while facing the same environmental conditions (Averina, Frishammar, & Parida, 2022; Do et al., 2022; Eller et al., 2020; Hopkinson et al., 2018). For instance, more and more companies are transforming their business model into a renewable one based on CE principles due to restrictions or incentives advanced by policymakers. Economic organizations can also seek legitimation by imitating other companies' approaches to renewable production systems to deal with uncertainties, while meeting new consumers' needs or stakeholders' requirements (Camilleri, 2020; Camoletto, Corazza, Pizzi & Santini, 2022; Centobelli et al., 2021; Fischer & Pascucci, 2017; Tunn, Bocken, van den Hende & Schoormans, 2019).

In addition, companies' isomorphism has been shown to be triggered as a consequence of their attempt to cope with uncertainties while pursuing efficiency (Do et al., 2022; Haunschild & Miner, 1997). The extended institutional theory integrates the economic variant into the previous sociological one, introducing three more mechanisms that drive companies to adopt similar practices and processes. Researchers have outlined how economic entities tend to (a) imitate practices adopted by a considerable number of organizations when they reach a critical mass of adopters (i.e., frequency-based imitation); (b) implement practices legitimized by a smaller group of other companies deemed successful or with higher status (i.e., trait-based imitation); and (c) become inclined through the observation of other businesses' outcomes following a managerial decision or implemented practice to resemble successful realities by mimicking the same practices (i.e., outcome-based imitation) (DiMaggio & Powell, 1983; Haunschild & Miner, 1997; Zucker, 1987). In this vein, companies may aim at translating circular purposes into their business model to tackle uncertainties, taking inspiration from widely adopted practices or successful circular processes traced back to a virtuous set of sustainability-sensitive actors (Carmona-Márquez et al., 2022; Hopkinson et al., 2018).

Overall, institutional theory suggests that the more firms adopt CE practices and embrace circular businesses, the more the legitimacy of converging business models toward a renewable production system is consolidated to cope with uncertainties (DiMaggio & Powell, 1983; Ranta, Aarikka-Stenroos, & Mäkinen, 2018). Both sociological and economic external variants offer six plausible mechanisms that can explain businesses' assonant approach in converging toward a more sustainable business model. Considering specifically the frequency-based and the trait-based imitation mechanisms in inducing isomorphism in companies, this convergence has also been associated with technological factors (Do et al., 2022; Haunschild & Miner, 1997). In the CE domain, it means circular businesses' isomorphism can be accessed via the adoption of digital technologies to support the circular transition, as a consequence of the environmental conditioning imposed by other actors' legitimized conduct (Bag et al., 2021; Gupta et al., 2019; Pizzi, Corbo, & Caputo, 2021). Through the mechanisms offered by these theoretical lenses, this study thus aims at investigating companies' tendency to employ digital supports in new products or revised processes to achieve a higher degree of circularity and, in general, promote sustainability in enterprises.

4.3 Research design

In consideration of the research question to be answered, alongside the scant awareness regarding the effective role of digital technologies in supporting SMEs toward their CE transition, this study has adopted a qualitative design. When little is known about a specific phenomenon, it seems appropriate to participate in the scientific debate through an explorative approach based on the observation and interpretation of events described by actors in their social realities (Blaikie & Priest, 2019; Marshall & Rossman, 2014). The authors engaged various companies with positivistic lenses to build new grounded knowledge resulting from abductive reasoning applied to a multiple case study (Eisenhardt, 1989; Glaser & Strauss, 2017; Piekkari, Welch, & Paavilainen, 2009; Timmermans & Tavory, 2012; Welch et al., 2022). Specifically, abductive reasoning offers a reiterative matching process of multiple sources of theoretical and empirical information, where contents from the extant literature and the factual world converge to enable the elaboration of plausible conclusions (Dubois & Gadde, 2002). The inquiry began with a comprehensive review of the previous literature on CE and businesses' digital transformation in preparation for the analysis of the empirical scenarios. Then, building on the integration of the researchers' expertise, the experiences actors

ascribe to their economic realities, and supplementary material from auxiliary sources, the case researchers have been driven to a convergent answer to the advanced research question (Hofmann & Zu Knyphausen-aufseß, 2022; Howard, Hopkinson, & Miemczyk, 2019; Yin, 2003). In doing so, the case researchers can provide new insights related to digital technologies adoption and Industry 4.0 in circular businesses.

4.3.1 Case selection and data collection

In their intention to examine the establishment of newly developed or converted circular businesses while focusing on the role of digital technologies, the authors have chosen to investigate business realities characterized by distinct operational agility and flexibility, specifically SMEs (Centobelli et al., 2021; Pereira et al., 2022; Pizzi, Corbo, & Caputo, 2021). Small and medium companies are generally considered agile organizations due to their size and structure, which confers on them the ability to quickly respond to changing environments, adapt to new circumstances, and implement prompt changes accordingly (De Angelis, Howard, & Miemczyk, 2018; Troise et al., 2022). In this manner, the agile and flexible nature of SMEs can be a significant advantage in a CBM establishment, as it allows businesses to quickly adapt, engage stakeholders, and collaborate, experiment, and optimize resource utilization according to CE principles. These characteristics enable SMEs to effectively implement circular practices, creating value from waste and minimizing resource consumption, thus promoting sustainable and responsible business practices (Dey et al., 2022; Mura, Longo, & Zanni, 2020). Accordingly, purposeful sampling has been administered as an effective means to identify those cases that can offer the most coherent and representative information to achieve the study's objectives (Marshall & Rossman, 2014; Ranta, Aarikka-Stenroos, & Mäkinen, 2018). Hence, the sample selection was based on small and medium businesses established in Italy that operate in sectors with the potential for engaging with CE, such as manufacturing, construction, chemical, fashion, food, and beverage (see Table 7). In line with the European Union definition of SMEs (European Commission, 2020b), we only involved companies with fewer than 250 employees and an annual turnover of less than €50 million (or less than a €43 million annual total balance sheet; e.g., Dey et al., 2022; Scuotto, Santoro, Bresciani & Del Giudice, 2017). Both threshold values were verified through Aida, a Bureau Van Dijk database that collects accounting data on Italian companies, alongside companies' information on LinkedIn and data collected during

interviews. This selection of cases represents a critical point in our study due to their significance on national and international productive systems, as SMEs represent 99.8% of European enterprises and 53% of the added value in the eurozone (Bertello, De Bernardi, Santoro & Quaglia, 2022; European Commission, 2021; Zhu et al., 2022). Moreover, SMEs provide a remarkable research context as they are characterized by a high level of agility and sustainable orientation (Caputo, Schiocchet & Troise, 2022; Chaudhuri, Subramanian, & Dora, 2022; Dey et al., 2022; Pizzi, Corbo, & Caputo, 2021).

Table 7 – Descriptive information of the case studies

Company	Sector/Business	Size	Interviewee's position	Time
A	Building and Construction	Small	Chief executive officer (CEO)	38 min 23 min
B	Tanning/Fashion	Small	Chief executive officer (CEO)	67 min
C	Manufacturing/ Machine Industry	Small	Chief executive officer (CEO) and co-founder, Business developer	50 min 38 min
D	Manufacturing	Medium-sized	Chief sustainability officer (CSO)	58 min
E	Manufacturing/ Design	Medium-sized	Business process and people management	69 min
F	Fashion/Textile	Medium-sized	Special project manager	71 min 47 min
G	Fashion/Textile	Micro	Chief executive officer (CEO) and founder	52 min
H	Services/e-mobility	Micro	Chief executive officer (CEO)	49 min
I	Chemical/ Cosmetics	Small	Chief executive officer (CEO), Production manager	41 min 65 min
J	Food and Beverage	Medium-sized	Chief executive officer (CEO), Production manager, Marketing manager	48 min 45 min
K	Food and Beverage	Small	Chief executive officer (CEO)	61 min
L	Furniture	Medium-sized	Chief executive officer (CEO), Chief sustainability officer (CSO)	45 min 60 min
M	Fashion	Small	Sustainability specialist	78 min
N	Manufacturing	Micro	Chief executive officer (CEO), Sales account	72 min
O	Fashion/Textile	Micro	Chief executive officer (CEO)	48 min
P	Pharmaceutica/ Chemical	Medium-sized	Chief executive officer (CEO), R&D director	50 min 49 min

Source: Authors' elaboration.

The study adopts a qualitative approach in the form of 16 case studies of circular businesses (Eisenhardt, 1989; Yin, 2003) whose information was mainly collected from managers and employees through semi-structured interviews (e.g., Franzò et

al., 2021; Hofmann & Zu Knyphausen-aufseß, 2022). This approach provides the opportunity for researchers to gather information about a business by keeping the conversation within chosen boundaries while leaving participants open to explore relevant aspects and experiences (Kvale, 1996; Timmermans & Tavory, 2012). Thus, data take shape from the interactions between the interviewer and the interviewee, undergoing a coding process based on the high level of reflexivity and the extensive knowledge possessed by the researcher (Silverman, 2015). Table 1 indicates the interviewees' roles in the sampled companies. In practice, the interview guide addressed the research questions in the form of a structured conversation and included the questions listed in Table 8. Overall, 23 face-to-face interviews were conducted, either in person, by telephone, or through virtual meetings held between May and November 2022. The interviews lasted 53 minutes on average and were recorded with the companies' permission while interviewers were taking notes. Thereafter, the researchers listened to the recordings and complemented their notes to enable the subsequent process of decoding and analysis while keeping interviewer-related errors to a minimum (Eisenhardt & Graebner, 2007; Silverman, 2015; Timmermans & Tavory, 2012; Yin, 2003).

Table 8. Interview guide

Questions
1. In line with your sustainable vocation, have you implemented any processes, practices, or developed products inspired by circular economy principles? How circular do you think you are?
2. When did your company become circular? Was there a transition to a circular business model, or was your company founded on a circular model? Explain: a) How has the translation toward a circular model occurred? Is it still ongoing? OR b) How has the business start-up process been based on circular economy principles? Describes how the implementation of circular practices has contributed to the establishment of your circular business.
3. Have you adopted digital technologies to support your business activities? What kind? Even those not related to circular processes. How digitized do you think you are?
4. In this regard, what role have digital technologies played in establishing circular practices or processes? Which of the digital tools you employed have helped you to realize a specific circular practice? Explain your going circular path by focusing on new products, processes or practices development, highlighting the role played by digital technologies.
5. Would you have been able to implement a circular business model without technological support? How have digital technologies helped you in your circularity goal?

Source: Authors' elaboration.

In line with the positivist tradition of this study, the case researchers sought new theoretical insights favoring replication toward a multiple case study design so as to strengthen the data analysis in providing analytical generalization (Piekkari,

Welch, & Paavilainen, 2009; Welch et al., 2022). According to Eisenhardt (1989), a multiple case study can be considered reliable when it is based on 4–8 empirical cases. However, the case researchers ensured robust results by persisting with data collection until theoretical saturation was reached, that is, when additional data no longer provided any new insight in terms of refining the properties of the coding categories or the context of analysis (Corbin & Strauss, 2007; Marshall & Rossman, 2014; O'Reilly, Paper, & Marx, 2012). The coding process was carried out with the intention of ensuring the stability of the results over time, context, and research tools so as to represent the objective phenomenon coherently with the study's positivist interpretation (Bauer, Gaskell, & Allum, 2000; O'Connor & Joffe, 2020). Thus, the authors envisaged an intercoder comparison and discussion in order to assess the accurate interpretation of the information gathered from the interviews. Intercoder reliability has been ensured through the convergence of case researchers toward an unambiguous interpretation of the data as suggested by Potter and Levine-Donnerstein (1999) and echoed by O'Connor and Joffe (2020) (e.g., Schwanholz & Leipold, 2020). Furthermore, we decided to take some supplementary precautions from previous studies' recommendations to ensure the validity and reliability of our study (Corbin & Strauss, 2007; Gibbert, Ruigrok, & Wicki, 2008; Marshall & Rossman, 2014). First, the interview guide has been structured by rephrasing questionnaires formulated in similar qualitative empirical analyses in the CE domain (i.e., Aranda-Usón et al., 2020; Franzò et al., 2021; Hofmann & Zu Knyphausen-aufseß, 2022). Secondly, participants in the research project were involved in validating the themes and interpretations during the interviews. Then, the overall process of data collection comprised a triangulation phase where empirical observations from participants were combined with various sources of information (i.e., company websites, sustainability reports, newsletters, and databases) to allow a better comprehension of the circular business development and increase trustworthiness (Gibbert, Ruigrok, & Wicki, 2008; Marshall & Rossman, 2014; Yin, 2003). Finally, we employed pattern matching by comparing our results with previous research observations (Eisenhardt, 1989; Eisenhardt & Graebner, 2007).

4.3.2 Data analysis

In social sciences, the grounded theory refers to a systematic research methodology that involves data collection and analysis to build new theoretical insights 'grounded in empirical observations of words, actions, and behavior of the study's

participants' (Corbin & Strauss, 2007; Glaser, 2007; Gligor, Esmark, & Gol̈geci, 2016, p. 97).Accordingly, the case researchers attempted to answer the research question by processing information from empirical cases to provide a theoretical contribution to digital technologies applied in the CE domain. Thus, the data analysis has been carried out by drawing on the information gathered from interviewees, combining researcher notes with the transcribed interviews, and referencing supplementary data. The collation of different data sources was performed by the authors to elaborate converging lines of inquiry toward a single explanation in accordance with a positivist approach (Eisenhardt, 1989; Piekkari, Welch, & Paavilainen, 2009; Thomas, 2021; Yin, 2003). As the perspective of this study is to understand how and why digital technologies are applied in circular businesses, the data analysis process was shaped accordingly. Relying on the grounded theory framework to build new theoretical concepts from empirical observations (Corbin & Strauss, 2007; Glaser & Strauss, 2017; O'Reilly, Paper, & Marx, 2012; Timmermans & Tavory, 2012), the authors performed a cross-case analysis to uncover generalizable constructs in a two-step procedure, where the translation of circular principles into feasible activities has been observed through the support of digital technologies in establishing the circular process. In the first place, the case researchers examined the development of each circular business observed. Thanks to the information on the progressive evolution of each sampled company, it has been possible to carry out a retrospective and prospective investigation aimed at capturing the entire development process of circular-inspired practices and processes within companies (e.g., Wamba, Akter, Edwards, Chopin, & Gnanzou, 2015; Zucchella, Previtali, & Strange, 2022). A longitudinal observation offered an understanding of circular business establishment and growth, as changing elements were observed from a holistic perspective (Eller et al., 2020). It allowed the case researchers to capture the dynamic responses to sustainable opportunities by circular businesses unfolding under different conditions, in terms of digital technologies adoption. Therefore, an in-depth investigation of cases was performed to provide an evolutionary framework, a common development path within which digital tools and systems found common purpose lines in supporting CE principles adoption in business processes. Complementarily, in the second step we rationalized the actual use of digital technologies in the identified circular processes and products thanks to the Gioia methodology (e.g., Bocken & Konietzko, 2022; Troise, 2021; Zucchella, Previtali, & Strange, 2022). This approach builds upon the grounded theory and ensures

methodological accuracy in qualitative studies through a precise and validated data structure (Gioia, 2021; Gioia, Corley, & Hamilton, 2013). Indeed, it has been developed as a complementary instrument of qualitative research to support procedural rigor in data analysis (Mees-Buss, Welch, & Piekkari, 2022). From the empirical investigation, the data have been analyzed and systematized into several first-order concepts by the case researchers, whose role is akin to a 'glorified reporter' that collects information in an unbiased manner, departing from the risk of 'going native' (Gioia, Corley, & Hamilton, 2013, p. 17–19). Then, these field facts are evaluated for similarities and differences to elevate them toward a theoretical understanding thanks to the experience and the researchers, who act as 'knowledgeable agents' (Gioia, Corley, & Hamilton, 2013, p. 17; Mees-Buss, Welch, & Piekkari, 2022). The structured theorizing process offered by the Gioia methodology thus outlines two different phases, where the researchers' role changes considerably from actors in charge of representing reality as truthfully as possible to expert analysts of the field capable of bringing the empirical evidence found in the case studies together. The development of second-order themes represents the processing of facts into constructs belonging to the theoretical realm (Corbin & Strauss, 2007; Glaser & Strauss, 2017; Gligor, Esmark, & Goİgeci, 2016; O'Reilly, Paper, &Marx, 2012), which can be further refined in new aggregate dimensions (Gioia, 2021; Gioia, Corley, & Hamilton, 2013). Therefore, the data structure realized by drawing on the Gioia methodology outlines the theorizing process' output in terms of results provided by the case researchers' ability to find assonances in the case studies and create logical relationships among categories from factual scenarios through grounded theory.

4.4 Findings

Building on the information collected during the empirical investigation, this research can offer some inspiring findings. Table 9 outlines the circular products or processes observed in the 16 case studies, alongside the digital technologies implemented in the observed CBMs. In general, the most common circular practices among the sampled SMEs have proven to be the recovery of waste as new resources to improve efficiency and reduce input provided by virgin raw materials. Some case studies showed integrated remanufacturing processes to collect and convert end-of-life products and scraps into new, secondary raw materials. With the intention of recovering scrap from the demolition of buildings, company A has set up a system for collecting its own (and other construction

companies') waste in order to produce secondary raw materials that can be used in the realization of future buildings. Another example comes from B, a company focused on the production of leather, whose raw materials are mainly made up of waste from the agro-food industry (goat, lamb, calf, or mutton hides). The chief sustainability officer of company D, which specializes in accessories manufacturing, supports these circular practices, noting that they '*apply circularity in the logic of symbiosis, which means to recover waste from our customer's supply chain to generate secondary raw material for our supply chain*.' Companies L and E, which, respectively, produce furniture and tableware, make extensive use of secondary raw materials from recycled plastic waste. Company M, on the other hand, is active in the fashion industry and manufactures outerwear made of polyester fiber that replaces the use of animal-derived inputs and product elements made of recycled plastic. Similarly, organization O also relies on the use of recycled raw materials recovered from agricultural industry wastage and renewed plastic to manufacture animal-free sustainable footwear. An excellent example of waste reduction through recovery strategies has been offered by the special project manager of firm F, who specified that it '*is nearly a zero-waste company that tries to recover 100% of the material we use, as at each stage of production there are companies in charge of recovering waste from the entire production process*.' Therefore, almost all of the investigated companies approach CE adoption in terms of resource or waste reduction, sometimes through recycling production wastage. That is the case of company G, which activated a recycling and remanufacturing process for end-of-life garments to obtain fabrics from secondary raw materials, with the aim of producing new apparel. An analogous perspective in the food and beverage sector sees the young company K embarking on a CBM that involves the recovery of unsold bread from the food industry to obtain yeast used in the production of premium craft beer. In the same industry, company J has established an upcycling process based on the extraction of nutrients from exhausted cereals used in the production of beer. This process is meant to save valuable nutrients from production scrap before being sold as feedstuff. These rich elements can be employed in new circular products as secondary raw materials. For instance, they can be utilized by companies such as I and P, which are committed to circular product development based on recovered nutrients from the food and beverage industry. Respectively, I and P are establishing their circular businesses based on input material reduction and waste recovery in the realization of sustainable cosmetics and food supplements derived from a circular ecosystem. Additionally,

the case researchers observed the development of a circular business by company N based on a circular product that prevents the generation of plastic waste. Thanks to their sustainable packaging for food, it is possible to replace the plastic film used in kitchens with an all-natural product that can be taken back at the end of its life to be treated and put back again on the market. This product take-back initiative for remanufacturing has also been observed in company L, even though in both cases the businesses are still in the design phase of the circular process. In dealing with waste reduction and recycling, company C also offers a peculiar case of CE integration into a business model. It produces circular supports for industrial use to ensure waste reduction in the food industry through precise item detection by machines employed to sort mixed waste for recycling. Another interesting perspective in terms of circular principles adoption in economic organizations has been offered by H, a company focused on engineering, testing, and validating services to support resource and energy-reducing practices in circular businesses.

In our wide investigation of circular businesses, the case researchers observed that digitalization has played a key role in the majority of cases regarding circular processes or product development. Indeed, spokespersons for 14 out of the 16 circular companies testified that digital technologies have had a high or moderate role in supporting their CE practices adoption (see Table 3). The chief sustainability officer of company D clearly expressed his view, agreeing with most of the SMEs interviewed that '*the technological revolution represents a boost for circular processes, increasing the speed and breadth of circular practices. Digital technologies open up new possibilities for the future of the circular economy.*' As a consequence, the case researchers committed themselves to exploring the path through which circular practice and processes have been implemented in SMEs, focusing more specifically on circular business requirements alongside the specific functions carried out by digital tools.

Table 9. Circular processes in sampled companies and digital technologies' role

Company	Circular product or process	Circular practices	Going circular stage	Digital Technologies' function	Circular practices support
A	Promote the reuse of waste or excess materials from construction through an interconnected virtual marketplace	Reduce Reuse Recover Recycle	First steps	A digital platform, alongside an IoT system, to enable inter-firm communication, spatial localization, and resource exchange/collection	High
B	Recover agri-food industry waste into secondary raw material to realize natural, chemical-free, and durable leather that is easily compostable at the final product's end of life	Recover Reduce Long-lasting design Recycle	Circular maturity	Use of big data and AI to optimize waste reduction in terms of energy and resources during product development (reduced water use and impurities released, less cutting waste) Digital system to allow supply chain tracking and certified circular product identification from clients and suppliers while AI delivers product information as a replacement for analogue media	Medium
C	High- and low-intensity extraneous object detection system to spot impurities in food products and allow action to be taken on the individual item to reduce food waste during the production process	Reduce	First steps	AI and machine learning, supported by automated systems, to enable object detection and immediately action to be taken to remove or sort elements with different densities; deep learning software to recognize different materials based on their composition	High
	High- and low-intensity extraneous object detection system employed to sort different types of waste and facilitate its recycling	Recycle			
D	Recover supply chain waste from customers to generate secondary raw material, which is employed into new eco-friendly-designed circular products that favor end-of-life recyclability	Reduce Recover Recycle	Circular climbing	Additive manufacturing to reduce energy and material use in circular production development IoT and sensors to allow data collection while AI exploits big data to enhance the transformation process, increasing the circular process rate of implementation and amplifying its scale	High
E	Recover plastic from post-consumption materials to generate new products almost entirely based on secondary raw resources employed in readily recyclable kitchen equipment production	Reduce Recover Recycle	Circular climbing	Additive manufacturing to enhance prototyping and production while saving energy and resources and reducing costs; in parallel, collaborative robots and warehouse automation through IoT to significantly intensify the circular products development rhythm	High

F	Waste reduction through the acquisition of exhausted fabrics from clients, which are remanufactured into virgin-equivalent fabric in terms of performance, durability, and appearance	Recover Remanufacture Reduce	Circular climbing	Digital platform and IoT systems to enhance garment collection by providing a direct connection channel with clients	High
	Production process from renewable sources with very low environmental impact, minimal use of chemicals and water, and low energy consumption	Reduce	Circular maturity	Production process and storage automation to allow activities optimization alongside waste and energy reduction	High
G	Collect and process of end-of-life garments into secondary raw materials from which new, easily recyclable circular products are manufactured	Reduce Recover Remanufacture	Circular climbing	A digital infrastructure to connect all stakeholders of the company, facilitating the collection of waste materials and their processing; utilizing the company's website to enhance worn clothes collection	Medium
H	Engineering, testing and validation services to support the development of sustainable and circular processes and products based on resource and material employment reduction	Reduce	Idea generation	AI, machine learning, and IoT to shape circular processes and product development in terms of increasing productivity, trend analysis, and obsolescence prevention	High
I	Development of circular cosmetic products with zero environmental impact, made using natural ingredients recovered from the food and beverage industry waste	Recover Reduce	First steps	IoT systems and digital platforms to facilitate the flow of information among the actors of the supply chain for the benefit of circular product development	Low
J	Through an upcycling process, recovery of waste from beer processing by partner companies to generate new secondary raw materials that are used in circular food and beverage products	Reduce Recover	First steps	Digital platforms and IoT supports to ensure real-time information exchange between different actors, enabling local circular ecosystem coordination during waste recovery and transformation into new resources	Medium
K	Collection and recovery of surplus bread from the food industry to produce new secondary raw material (i.e., yeast) employed in premium beer production	Recover Reduce	Circular climbing	An information system available to partners to improve waste collection from large and small players in the agro-food industry; automated processes supported by real time data collection to enhance the transformation process in terms of scale and efficiency	High
L	Waste and raw material reduction through a take-back process of end-of-life furniture products that can be disassembled and remanufactured into new circular products based on recovered components	Reduce Recover Refurbish Remanufacture	Idea generation	Tracking technologies and IoT to allow furniture recovery and offer support for consumers to proactively return an exhausted product; digital support such as an near-field communication (NFC) or QR code to offer product information, which can be retrieved from an AI to explain the automatic disassembling process	High

M	Animal-free outerwear made from secondary raw materials obtained by recycling waste and designed to be long-lasting and easily recyclable	Reduce Recover Recycle	Circular maturity	Big data, AI, and machine learning to make production processes more efficient and optimize business circularity; IoT to support partner interaction and circular product development by connecting actors from the value chain	Low
N	Circular product designed for food preservation made entirely from natural materials with no environmental impact as a replacement for disposable plastic film; end-of-life take-back process allowing remanufacturing to restore the product's properties so as to re-enter the market	Reduce Remanufacture	Idea generation	IoT and digital platform assisted by tracking systems to allow information sharing and facilitate customers during the take-back process	High
O	Animal-free circular fashion products made from secondary raw materials derived from agricultural waste and recycled plastic	Reduce Recover	Circular maturity	IoT systems, big data analytics, and AI supports to allow data collection and analysis to monitor carbon footprint and production externalities so as to offer a cleaner transformation process and product development	Medium
P	Processing of food industry waste to generate new secondary raw materials, which are used for new circular products in the form of food supplements	Reduce Recover	Idea generation	IoT to support circular product development through real-time information exchange between different partners, enabling waste recovery and secondary raw material use in circular products	Medium

Source: Authors' elaboration.

4.4.1 Outlining the going circular path

At first, the longitudinal observation allowed us to gather information on the CBMs from a retrospective and perspective point of view, uncovering some common development patterns. It has been possible to observe how, over time, businesses acquire an increasing degree of circularity by taking into consideration: (a) the origin of resources fed into the production process (raw materials or recovered/remanufactured secondary raw materials); (b) the externalities deriving from the transformation process and auxiliary activities; and (c) the properties of production outputs in terms of recyclability, lifespan, and reutilization. Thanks to an accurate description of each circular process or product development, a recurring series of evolutionary stages have been identified as a *going circular path*. The authors identified four distinct phases of evolution in relation to the aforementioned degree of circularity of companies. In order, they are *idea generation, first steps, circular climbing*, and *circular maturity* (Table 9).

In the idea generation phase, the case researchers identified a preparatory process of developing a circular product or process, wherein a company attempts to apply concrete CE principles to create an economically sustainable business. Company L offers an example of this step through the preliminary definition of a take-back process for their products. In this case, the circular process design has started by considering the materials employed in their furniture to make circular product components that can be easily recycled and remanufactured. A similar condition has been found in company N, where the collection process of spent products is being developed and transformed by evaluating possible opportunities to remanufacture end-of-life products. Relatedly, company P was also observed in the very first step of their circular product development. The chief executive officer and the R&D director explained how their effort is actually related to the identification of what raw materials, in the form of nutrients, could be employed in the production of food supplements. Overall, it has been possible to outline a preliminary condition of idea generation where the management recognizes a circular opportunity and endeavors to design the circular initiative according to the firm's conditions.

Next, a circular business takes its first steps through the marketing of a finished circular product or service, behind which there is a structured process that incorporates the most common circular practices. The current situation of company

A offers a practical example of this second step. After having accurately identified and set up the circular process it wants to put in place, the firm is concretely proposing an initiative to collect unused raw construction materials and demolition scrap from other stakeholders to activate the reuse and recovery process. Analogously, company C has identified a circular opportunity and realized mechanical support for circular businesses in its first step, and, at the time of the interview, the chief executive officer was actually considering the first industrial application of their machine for recycling processes and reducing waste. Meanwhile, the management of company I, after defining a circular cosmetic product based on nutrients derived from the agro-food industry, is dealing with the definition of the marketing mix and first commercialization of its circular product. Company J has also already designed the upcycling process through which they can extract resources from exhausted cereals previously used in brewing. Thus, it was possible to observe this company in the second step of its *going circular path* dealing with the employment of secondary raw materials in circular products (i.e., snacks and beverages) and their placement on the market. Based on these circular business experiences, the case researchers outlined this second step, where the circular process or product has been designed and developed by the company, and it is facing its first implementation or introduction onto the market. This first steps stage seems to be characterized by a slow increase of the circularity degree recognized in enterprises that can be substantially raised thereafter.

Indeed, the next step involves an increase in the adoption of the circular product, which corresponds to the greater breadth of a circular process by involving new stakeholders. In this third step, identified as circular climbing, the degree of recovered or remanufactured raw materials employed in circular businesses increases significantly, alongside the reduction of externalities from production and the utilization of a circular product. Expanding the production process of environmentally sustainable tableware goods made from recycled plastic, company E offers an example of circular business scaling through the launch of an entire line dedicated to circular products. This example shows how they went from defining a circular opportunity to prototyping an initial model of a home accessory made from recycled plastic materials to expanding the range of circular products sold. In this way, it was possible to observe the sudden rise in the degree of circularity of the company, which was associated with an increased recovery of waste in addition to the material and energy reduction inputs in the production of

its table accessories. Similarly, companies G and F approached the circular climbing phase through the massive expansion of suppliers capable of providing them with the exhausted garments needed to enable the recovery of fabric filaments used to produce new clothes. After the design of the circular process and the circular business' first step into garments remanufacturing, the degree of circularity of both companies has seen exponential growth in terms of the amount of recovered waste from the fashion industry and the reduction of new materials used in their garments. Company K is also experiencing circular climbing through the considerable growth of unsold bread suppliers and the subsequent expansion of their yeast extraction process to produce craft beer.

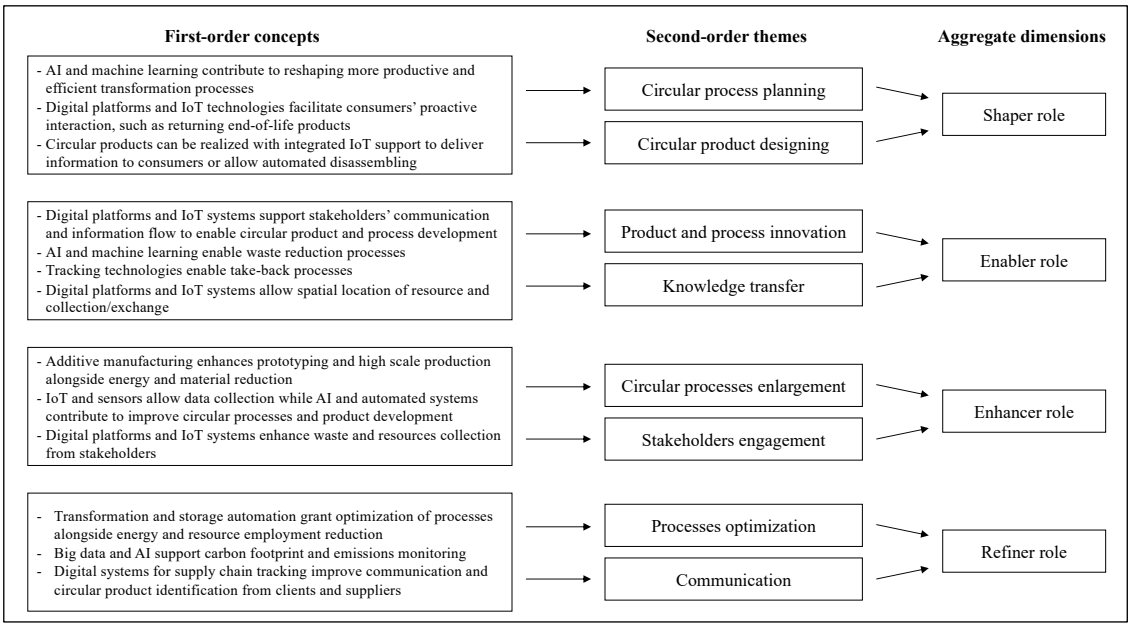
Finally, the case researchers also observed how circular businesses tend to reach a state of circular maturity, where the circular degree growth slows down and stabilizes. Such is the case with company B, where the circular climbing step, represented by the intensification of leather recovery from food industry scraps, has been followed by an attempt to refine the circular business. In other words, B's chief executive officer testified that they are committed to further reducing material and energy inputs, as well as production externalities, to achieve a higher level of business sustainability. The special project manager at company F agreed with this circular strategy. In fact, company F's circular maturity can be observed in its commitment to further reduce its production process' environmental impact by avoiding chemicals and drastically reducing the employment of water and energy in garment thread recovery and garments manufacturing. Similarly, company O was attempting to perfect the circularity criteria of their business by increasing the amount of secondary raw material recovered for the production of sustainable sneakers along with reducing production-negative externalities. Thus, this last step of the *going circular path* provides the opportunity to refine a circular business by improving the environmental, social, and economic benefits of a renewable production and consumption system.

4.4.2 Four roles for digital technologies in circular businesses

Overall, our in-depth longitudinal investigation provided an evolutionary framework of circular business development, where digital tools and systems found common purpose lines. Thus, the empirical investigation was complemented by a cross-case analysis based on a transparent data structure, represented in Figure 10. The results revealed four main roles of digital technologies in circular

businesses that agile organizations pursue through the adoption of digital tools: *shaper, enabler, enhancer*, and *refiner*. Each aggregate dimension is supported by two second-order themes and several first-order concepts found in the case studies.

Figure 10. Data structure



Source: Authors' elaboration.

The four roles of digital technologies within circular businesses satisfactorily fit within the evolution described through the *going circular path*. During the idea generation step, digital technologies, such as IoT and tracking systems, or the possibility of recurring to AI, machine learning, and IoT, shape the definition of the circular practices themselves. This role is supported by the chief sustainability officers of company L, who stated '*considering available technologies, we intend to activate a take-back process using digital support to ensure traceability, as well as include intelligent elements within the blend that dialogue with our machine once they have to be disassembled*.' Indeed, L's take-back, circular process is being designed according to the tracking properties offered by digital tools. In this way, their *smart furniture* would integrate a QR code or near-field communication chip that returns information to the end consumer about how to contact the company to initiate the end-of-life take-back process of the product. Furthermore, it would be possible for L to have intelligent end-of-life products that can communicate to an AI about an item's material composition and how to disassemble it. The chief executive officer and the sales account of company N concurred with this role of digital technologies as their circular process for acquiring and remanufacturing end-of-life food-protecting cloth is being designed according to the opportunities

afforded by digital technologies. Among the alternatives being considered is the use of a QR code alongside a digital platform to put the company in contact with the customer to arrange the collection of used items. In this vein, circular products tend to be shaped according to digital technologies implementation in circular businesses. As the chief executive officer of company H confirms, '*AI, machine learning, and IoT actively shape circular processes and product development in terms of productivity increasing, trend analysis, and obsolescence prevention*.' Through these examples, it was possible to outline the shaper role of digital technologies in terms of circular process planning and product designing oriented by the opportunities offered by business digitalization.

Secondly, companies in the first step stage have confirmed that the use of digital technologies enables them to initiate circular practices. As the chief executive officer of company A clearly explained, 'a*n interconnected system of exchange and sale of raw materials between players in the construction industry would not be possible without adequate technological support. Digital technologies offer interconnectivity, geographic identification, and information on raw materials (such as certifications) so that a company can directly acquire resources from the warehouse of someone else who does not use them, instead of buying a new one*.'

In company C meanwhile, AI and machine learning enable object detection and, with the support of automated systems, immediate action to be taken to remove or sort items with different densities. Deep learning software recognizes different materials based on their composition, enabling a circular processes aimed at reducing food wastage or recycling mixed waste. Likewise, the chief executive officer and the production manager of company J observed that '*certain circular processes need a digital component to enable stakeholders' coordination and information flow among the actors of a circular ecosystem*.' A similar function of digital technologies can be found in company I, where digital communication systems enable stakeholder coordination and waste material recovery to provide secondary raw materials used in cosmetics production. Overall, grounded observation of these economic realities has made it possible to outline the enabling role of digital technologies in circular businesses based on product and process innovation and knowledge transfer and communication among stakeholders.

In the expectation of accentuating the growth of their circular business, according to the circular climbing stage, the role of technologies becomes that of an enhancer that can further optimize and streamline the circular processes in place. As the

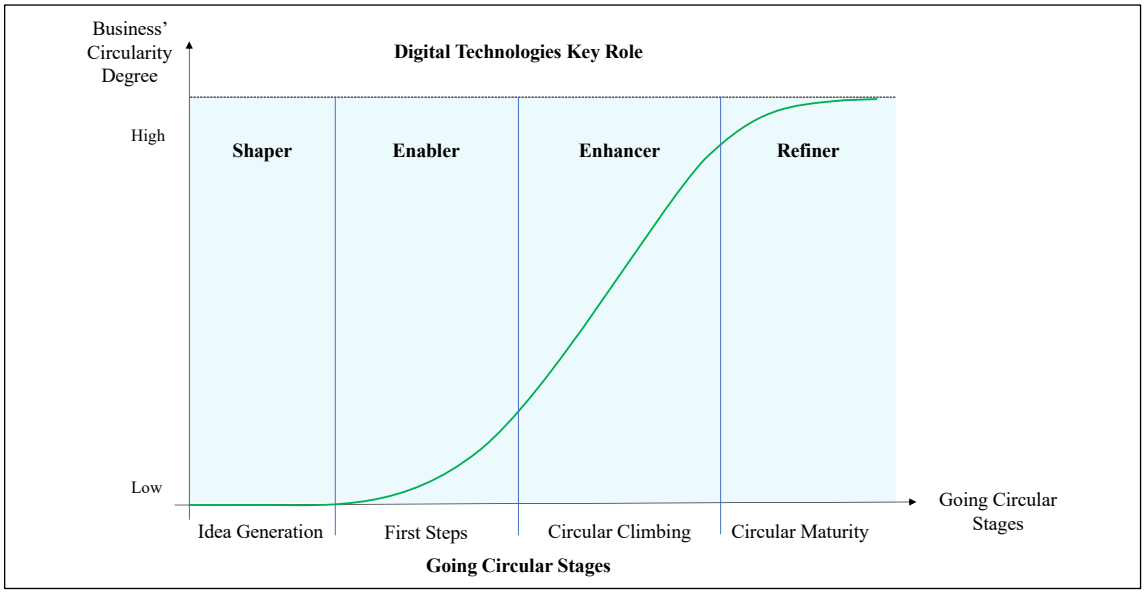
special project manager of company F declared, '*we have enhanced waste recovery through a digital system, connecting our company with customers. Without digital technologies, we would not succeed in building the circular business we have today*.' From this experience, it was possible for company F to notice how sometimes digital technologies also work to enhance the circularity degree of a firm. Thanks to digital platforms and IoT systems, F's circular business entered the circular climbing stage through the engagement of several stakeholders and the enlargement of the circular process. In fact, both companies F and G have set up online collection systems for exhausted textiles directly aimed at end consumers, providing an incentive to recycle their garments. Furthermore, the critical enhancing role of digital technologies has been observed in the digital infrastructure built by organization G to organize garment collection from upstream stakeholders and optimize it by sharing information on the fabrics being processed. As such, the case researchers came to define enhancer as the third role of digital technologies, supporting the expansion of a CBM toward a circular climb.

Finally, in more mature circular businesses, digital technologies have been applied to optimize circular processes and further advance the degree of circularity. In this way, product development can be refined to become even more efficient, emphasizing the characteristics that tend to close the loop. As the chief executive officer of company F clearly stated, *'We aim to be a zero-waste company; we try to optimize each stage of the production process to use only natural products, reduce the use of energy and raw materials, and limit production waste as much as possible. In doing so, [company F] is pursuing to be 100% circular.'* This statement expresses company F's aspiration to constantly achieve a greater degree of circularity by reducing waste as much as possible and closing the loop. This goal requires aiming at the circular process optimization of renewable production and consumption systems in the fashion domain. Correspondingly, it was possible to investigate digital technologies implementation in company O in terms of data collection and analysis to support the monitoring of emissions and the carbon footprint of its sustainable sneakers. At the same time, in company M, circular maturity has been achieved through the employment of big data, AI, and machine learning technologies to make production processes more efficient and optimize business circularity, with IoT supporting partner interaction and circular product development by connecting actors in a circular value chain. The communication

element of a CE strategy has also been observed in company B as a tool to optimize the value generated from a CBM. In this case, the employment of digital systems allows supply chain tracking and certified circular product identification from clients and suppliers, while AR delivers product information as a replacement for analog media. Company B's chief executive officer also mentioned their use of big data and AI to optimize the waste reduction of energy and resources during product development. In their circular maturity, the firm is still struggling to reduce water input in leather production and impurities released by the transformation process, along with the reduction of cutting waste through the use of precision technologies. As a result of these observations, we have therefore identified the role of refiner based on the needs and respective use of digital technologies by circular businesses facing circular maturity.

To summarize, we obtained a newly developed model that represents circular business development by parsing the different roles that digital technologies may assume to support each step of the *going circular path* (Figure 11). Finally, we would like to point out that the *going circular path* is meant to be an explanatory model of the evolution of a circular business, where the various functions of digital technologies (i.e., shaper, enabler, enhancer, refiner) are embedded. Although these steps could overlap, for instance by pursuing an optimization strategy while a circular climbing process is in progress, they represent an attempt to model reality and are therefore subject to the heterogeneity of companies, the context in which they are located, and the complexity of CBMs.

Figure 11. Digital technology's role according to the going circular path



Source: Authors' elaboration.

4.5 Discussion and theory building

Through the theoretical lenses offered by the extended institutional theory (DiMaggio & Powell, 1983; Haunschild & Miner, 1997; Meyer & Rowan, 1977), the authors investigated economic organizations' isomorphism in adopting digital supports to translate CE principles into feasible circular products and processes. This research built on previous scientific contributions that outlined the association of circular businesses with digital transformation and Industry 4.0 (e.g., Chauhan, Parida, & Dhir, 2022; Dantas et al., 2021; Gebhardt et al., 2022; Hina et al., 2022; Liu et al., 2022; Pizzi, Corbo, & Caputo, 2021; Ranta, Aarikka-Stenroos, & Väisänen, 2021). Although numerous authors have contributed to designing an interesting picture of digital technologies' implementation in CBMs (e.g., Franzò et al., 2021; Ghobakhloo, 2020; Kristoffersen et al., 2020; Pizzi, Leopizzi, & Caputo, 2021), the present study responds to the compelling lack of guidance on the implementation of digital technologies according to their function in granting a higher degree of circularity to sustainability-sensitive businesses (Chauhan, Parida, & Dhir, 2022; Kristoffersen et al., 2020). Based on empirical cases described in the CE literature or policymakers' publications (e.g., European Commission, 2023), it is clear how digitization is profoundly affecting traditional business models and, increasingly, how this is coupled with the transition to renewable production systems. In this context, we believe our attempt to outline a more detailed perspective of circular business evolution according to the adoption of digital technologies offers solid support for scientists and practitioners. Notably, the contribution of this article is based on SMEs and thus winks at economic realities characterized by organizational agility and flexibility, as well as dynamism, in response to external conditions (Chaudhuri, Subramanian, & Dora, 2022; De Angelis, Howard, & Miemczyk, 2018; Dey et al., 2022; Pizzi, Corbo, & Caputo, 2021; Troise et al., 2022). Drawing on the discussion of our findings, some inferences can be delivered for building theory in the CE domain. Hence, the authors advance the conceptualization of five original propositions supported in this section.

As a result of our multiple case study, we deliver an original *going circular path* expressed through our model represented in Fig. 2. The case researchers observed how digital technologies intervene in four specific circumstances in the establishment of a circular business: (a) during the idea generation phase, where circular practices are shaped according to available digital supports; (b) when the

circular business is taking its first steps facing markets or stakeholders, where they act as an enabling factor for the initiation of a CE practice; (c) through the circular climbing phase, where they represent a critical factor for enhancing the sharp growth of organizations' degree of circularity; and (d) during the circular maturity stage, when they help refine a circular practice or product development. These enlightening findings allow us to participate in the literary debate around circular businesses by bringing together several studies and offering new insight into the subject. More specifically, we build on the work of Franzò et al. (2021), which outlined an early phase of idea generation based on circular product development. Coherent with our findings, the path toward the establishment of a circular business goes through the assessment of resources and support that the company owns or can acquire, along with technological possibilities, stakeholder participation, and market appreciation (Lilien, Morrison, Searls, Sonnack & Hippel, 2002; Panizzolo, Biazzo & Garengo, 2010; Pinheiro et al., 2018). The present research emphasized the role of digital technologies in shaping circular businesses' idea generation wherever they can effectively support the translation of CE principles into feasible practices. As suggested by previous studies, companies can take advantage of digital platforms and communication systems to allow stakeholder interaction and collaboration (e.g., Gebhardt et al., 2022; Pizzi, Leopizzi, & Caputo, 2021), IoT systems to monitor or collect data in smart factories (Rejeb et al., 2022; Rusch, Schoğ gl, & Baumgartner, 2022), and big data analytics and AI forecasting to assist in decision-making (e.g., Gupta et al., 2019; Jabbour et al., 2019; Liu et al., 2022; Ranta, Aarikka-Stenroos, & Väisänen, 2021) or developing lean production and additive manufacturing systems (Dahmani et al., 2021; Sanchez, Boudaoud, Camargo & Pearce, 2020). As such, new cutting-edge technologies offer more and more opportunities for slowing, narrowing, and closing resource and energy flows (Bocken et al., 2016; Dantas et al., 2021; Geissdoerfer et al., 2018; Kristoffersen et al., 2020). In this regard, the perspectives offered by digital tools available to businesses (or not) inexorably condition and shape the exploitation of sustainable opportunities through the adoption of CE principles (Averina, Frishammar, & Parida, 2022; European Commission, 2023; Khan et al., 2020). We can thus advance the following proposition:

P1: Available or acquirable digital technologies shape the design of circular practices in terms of process planning and product designing, so as to orient circular business establishment.

In considering the first steps phase of the *going circular path*, our results suggest that digital technologies represent an essential means without which it would not be possible to achieve certain circular practices. Thus, we outlined their enabling role in the realization of circular processes or product development. These findings are supported by the CE literature, where previous studies have recognized the magnitude of business digitalization in achieving circular practices (e.g., Chaudhuri, Subramanian, & Dora, 2022; Chauhan, Parida, & Dhir, 2022; Kristoffersen et al., 2020). In agreement with Ranta, Aarikka-Stenroos, & Väisänen (2021), Rusch, Schoğgl, & Baumgartner (2022), and Wilts et al. (2021), our empirical investigation confirmed the enabling role of big data management in conjunction with AI and machine learning systems for streamlining waste, recovery, and recycling processes. Also, digital platforms and IoT technologies were shown to enable data collection and inter-firm communication, localization, and resources exchange or collection based on circular initiatives (Gebhardt et al., 2022; Kerin & Pham, 2019; Rejeb et al., 2022). Therefore, this study contributes to enriching the literary segment straddling CE and digital transformation by contextualizing when companies are required to rely on digital technology to substantiate a circular practice (Huynh, 2021). It furthers academics' and practitioners' knowledge by highlighting the distinction between the enabling function of digital technologies and the enhancing function found during the circular climbing phase. Initially, digital technologies can be used to introduce and implement a circular practice, ensuring a modest increase in the degree of circularity. At a later stage, circular businesses may then perceive the need to further employ digital tools to support the scalability of circular practices. We theorize on the basis of previous studies, where either this difference has not been clearly unfolded or findings have not been embedded in a well-defined evolutionary pattern. For instance, Chauhan, Parida, and Dhir (2022) and Kristoffersen et al. (2020) advanced two reviews based on literature and practice evidence in which digital technologies have been blurrily considered as circular strategies enablers and enhancers in newly developed frameworks to support companies' CE transition. In line with the enhancing function of digital supports, Bag et al. (2021) outlined how big data analytics can be leveraged to enlarge sustainable manufacturing and CE capabilities to achieve a higher degree of circularity. Similarly, Khan et al. (2021) concluded that blockchain technologies can act in favoring CE practices (i.e., circular purchasing, circular design, recycling, and manufacturing), which in turn can represent higher environmental

and financial performance. Liu et al. (2022) also back up our findings by outlining some digital functions aimed at specifically enhancing CE strategies while focusing on data collection and integration, data analysis, and automation in improving CE performance. As such, this study builds on the previously recognized role of digital technologies to advance an original perspective that emphasizes the enabling and enhancing roles of digital technologies against two distinct needs recognized in circular businesses: initiating a circular process or developing a circular product versus widening the range of a circular practice. According to these roles attributed to digital technologies during businesses' *going circular path*, the following propositions can be posited:

P2. Digital technologies enable circular principles translation and integration in businesses for implementing circular processes and realizing circular products and services.

P3. Digital technologies enhance circular processes enlargement and circular products adoption by leveraging stakeholders' engagement, accentuating the scope of circular practices.

Last but not least, our conceptual model advances the ultimate stage of the *going circular path*: circular maturity. Drawing on the empirical cases we had the opportunity to closely observe, it is possible to conclude how circular businesses' major needs at this stage are process efficiency optimization and cost reduction. The circular maturity stage is ascribable to companies characterized by an advanced degree of circularity, where digital technologies are employed as circular strategy refiners. For instance, data collection and analysis systems were shown to be used to monitor emissions and externalities of circular products and processes. Here, big data, AI, and automated systems come into play to optimize energy and resource input, as well as to reduce waste in production processes and enable recycling practices. Also, IoT can be leveraged to further improve supply chain coordination and communication. In agreement with our findings, Liu et al. (2022, p. 331) highlighted the "optimize" function of digital technologies as an attempt to "improve performances and reduce negative impacts, such as increasing efficiency and reliability in the production system while reducing emissions and energy consumption." In previous studies, process circularity has been shown to be related to production cost reduction, alongside the implementation of innovative circular practices (Darmandieu, Garcés-Ayerbe, Renucci & Rivera-Torres, 2022; Jabbour, Jabbour, Godinho Filho & Roubaud, 2018; Yang, Fu & Zhang, 2021).

Therefore, our research effort complements these earlier studies by identifying a specific phase in which circular businesses capitalize on digital technologies as a refining tool in circular strategies. The following proposition is thus put forward:

P4. Digital technologies can be implemented to further refine a circular business in terms of process

optimization and communication to stakeholders, aiming toward an entirely renewable business.

In addition, the case researchers managed to observe on various occasions how digital technologies can effectively foster circular practices implementation in companies. Consistent with prior studies (e.g., Chauhan, Parida, & Dhir, 2022; Dantas et al., 2021; Kristoffersen et al., 2020; Liu et al., 2022; Pizzi, Leopizzi, & Caputo, 2021; Ranta, Aarikka-Stenroos, & Väisänen, 2021), we reinforce the link between digitization and sustainability in business. In different circumstances, digital transformation provides companies with the means to exploit sustainable opportunities through process adaptation or innovative circular product development. This study highlights how the proper exploitation of digital tools in establishing circular practices also depends on the specific function they can play according to the degree of circularity of the business. Therefore, we can advance the following last proposition:

P5. Overall, digital transformation (and Industry 4.0) effectively supports the development and thriving of circular businesses as long as digital technologies are properly exploited according to their job to be done.

4.5.1 Theoretical contributions

In summary, it is possible to identify some major contributions to theory as a result of the abductive abstraction of the information grounded in our case studies. First, the present study enriches the CE literature by advancing a *going circular path* that outlines four evolutionally stages of circular businesses according to their degree of circularity. Based on the origin of resources employed, the externalities deriving from production and auxiliary activities, and the properties of circular products and services, a common path has been outlined that systematizes the adoption of CE principles in agile organizations (Bocken et al., 2016; Franzò et al., 2021; Hopkinson et al., 2018; Lüdeke-Freund, Gold, & Bocken, 2019; Santa-Maria, Vermeulen, & Baumgartner, 2022). As a second contribution, this research unveils

four functions fulfilled by digital technologies in undertaking a CE transition to achieve a higher degree of circularity. Building on assimilable circular strategies involving digital tools identified in previous studies (e.g., Bag et al., 2021; Jabbour et al., 2018; Khan et al., 2021; Liu et al., 2022; Pizzi, Leopizzi, & Caputo, 2021; Ranta, Aarikka-Stenroos, & Väisänen, 2021), the authors improved digital technologies adoption awareness in circular businesses through the association of a specific role with each step of the *going circular path* (Chauhan, Parida, & Dhir, 2022; Kristoffersen et al., 2020; Liu et al., 2022; Pizzi, Leopizzi, & Caputo, 2021). Third, we deliver some important considerations regarding how SMEs transition toward a renewable production and consumption paradigm (Centobelli et al., 2021; Darmandieu et al., 2022; Dey et al., 2022; Mura, Longo, & Zanni, 2020; Zhu et al., 2022). More precisely, this article unveils SMEs strategies for translating CE principles into circular processes and products thanks to the support of digital technologies and Industry 4.0 structures (Chaudhuri, Subramanian, & Dora, 2022; Pizzi, Corbo, & Caputo, 2021; Troise et al., 2022). Although this study took into consideration SMEs due to their agile and flexible condition in approaching CE, we believe our findings can also be applied to ambidextrous organizations due to their similar traits (Bresciani, Ferraris, & Del Giudice, 2018; Chaudhuri, Subramanian, & Dora, 2022; Jain et al., 2020; Marrucci, Rialti, & Balzano, 2023; Scuotto et al., 2017). In conclusion, the fourth contribution of the study is addressed toward the enrichment of the extended institutional theory in the CE domain (DiMaggio & Powell, 1983; Haunschild & Miner, 1997; Meyer & Rowan, 1977). We contribute to earlier studies in depicting circular businesses isomorphism (e.g., Do et al., 2022; Jain et al., 2020; Meherishi, Narayana, & Ranjani, 2019; Ranta, Aarikka-Stenroos, & Mäkinen, 2018) by advancing the perspective of CBMs' legitimation of business digitalization. More specifically, the present research succeeds in furthering circular businesses isomorphism's appreciation of implementing digital technologies by offering four different perspectives of the basis of digital tools integration.

4.5.2 Managerial implications

Furthermore, our results generate remarkable implications for chief executive officers, chief sustainability officers, and sustainability specialists who are attempting to translate their businesses according to CE principles. In the form of best practices and guidelines, this study provides a *going circular path* for organizations yearning to embrace CE and suggests how the application of digital

technologies can improve their circularity degree. Thus, practitioners can rely on an evolutionary roadmap to plan a circular business transition or to improve the circularity degree of their organization. Accordingly, managerial figures committed to sustainability may take advantage of the advanced conceptual model while considering which digital tool or support best fits their business' available resources and technological facilities. In the long run, we hope to inspire the implementation of CE practices among sustainability-sensitive companies to increase the widespread adoption of circularity in the world and close the Circularity Gap.

4.5.3 Future research avenues

The present research highly encourages future studies to expand the awareness of each step of the *going circular path* and focus on the advanced roles of digital technologies in supporting the circular transition. From now on, in fact, it might be worthwhile to unpack the circularity transition of sustainability-sensitive organizations. Doing so would offer a better conceptualization and support to the chief sustainability officers and sustainability specialists, providing a compass capable of navigating these managers through the circular business transition. Furthermore, this research is also intended to highlight the need for further quantitative studies on the subject, particularly ones aimed at assessing the relationship between the adoption of digital technologies and the success of circular businesses. Other aspects, such as agility or the presence of organizational flexibility, could in turn improve the starting conditions of businesses and facilitate their approach to a renewable system (Dey et al., 2022; Jain et al., 2020; Troise et al., 2022). In addition, future studies could consider the difference between circular businesses that operate according to a B2B or B2C approach, as well as considering the approach of native circular companies versus adopters that approached a circular transition from the linear economy (Rovanto & Bask, 2021).

Such a fascinating research stream can also find new research opportunities in the incorporation of the serendipitous dimension in the advanced model (Balzano, 2022; Dew, 2009). Since luck has often been acknowledged as a relevant factor in explaining organizational phenomena, some types of luck, such as serendipity, can be included as an external factor in the strategic formulation and managerial processes of circular businesses. Due to the rapid approach to business model innovation required while dealing with sustainability and digitization, the

serendipitous dimension could yield interesting insights offering an agile and flexible strategy exploiting sustainable opportunities (Averina, Frishammar, & Parida, 2022; Mirvahedi & Morrish, 2017). In this vein, future scholars could implement the *going circular path* with a serendipitous dimension, for instance by exploring the serendipitous effects related to the adoption of digital technologies in effectively fostering business circularity in SMEs.

On the other hand, the CE and digital transformation fall into the naturalized constructs belonging to the management field, which has been typically framed as positive in nature (Adler, Forbes, & Willmott, 2007, p. 126). Thus, the majority of the authors dealing with these topics are nearly always concerned with the positive behavior, conditions, and outcomes of digitalization and sustainability in businesses. Future studies could investigate the counter side of the coin by challenging such normalized assumptions to uncover conditions under which digital technologies and circularity in businesses lead to a series of undesired outcomes. For instance, we encourage exploring the potential challenges and risks associated with the adoption of digital technologies in circular businesses, such as data security, privacy concerns, technological complexity and skills gaps, change management and organizational culture issues, the digital divide among SMEs, and so on.

4.6 Conclusions and limitations

In conclusion, this qualitative paper has explored the adoption of digital technologies in SMEs within the context of the CE. Through a multiple case study analysis conducted wearing positivist philosophical lenses, the research provides valuable insights into the ways in which SMEs leverage digital transformation to embrace CE principles. Our findings led to the development of a *going circular path*, where digital technologies assume different functions – shaper, enabler, enhancer, and refiner – according to a company's circularity degree. By adopting digital technologies according to the advanced conceptual model, SMEs can seize opportunities related to the CE and overcome different barriers in establishing circular processes or developing circular products. Thus, the present study has recognized and confirmed several benefits arising from the integration of digital technologies in circular businesses, including increased resource efficiency, improved supply chain management, enhanced stakeholder engagement, and the development of innovative circular products and services.

It is important to acknowledge the limitations of this research, however. Firstly, the study focused solely on SMEs, and the findings may not be applicable to larger entities characterized by a less agile and flexible organizational structure. In addition, this research does not take into consideration the distinction between B2B and B2C circular organizations, or the possibility of examining separately born circular businesses (i.e., natives) and entities transitioning from a linear model to a CE (i.e., adopters) (Rovanto & Bask, 2021). Finally, even though the research is based on a qualitative in-depth analysis of several multiple case studies, the generalizability of the findings is still limited by the number of firms observed. Further research using quantitative methods, besides having a larger sample size, could provide a complementary understanding of the effectiveness of digital technologies in establishing sustainability-sensitive organizations.

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CHAPTER FIVE

Bridging Innovation Management and Circular Economy: An Empirical Assessment of Green and Open Innovation[4]

Abstract

Seeking a successful balance between economic growth and the natural environment, more and more companies are attempting to embrace circular economy (CE). Yet, how to take the first step towards the circular transition? This study answers such an important question by delving into innovation management to support the implementation of CE in businesses. More specifically, the present research addresses the nexus between green innovation and CE in economic organisations, besides observing the adoption of open innovation strategies. Green innovation, understood as a learning process through the adoption of novel practices, technologies, or products, has been associated with CE implementation, although their effective relationship has typically been overlooked or assumed. On the other hand, open innovation may further accelerate circular-oriented innovation, encompassing a collaborative approach where companies leverage external ideas and technologies. Using covariance-based structural equation modelling on a sample of 318 European companies, our study examines the interplay between such phenomena. We find that green product and process innovation enable companies to acquire resources critical for implementing CE practices, especially when relying upon open innovation mechanisms. As a result, this study demonstrated the synergic adoption of these innovation strategies, offering new insights based on generalisable claims. Building on the resource-based view of the firm, we substantiate the importance of environmental awareness in innovation processes and engaging in stakeholder collaboration, to acquire key resources and knowledge that facilitate the CE implementation. Accordingly, the article delivers practical recommendations for managerial figures by underlining how to harness innovation management to move their first steps towards the CE transition.

[4] Perotti, F. A., Troise, C., Ferraris, A., Hirwani Wan Hussain, W. M. Bridging Innovation Management and Circular Economy: An Empirical Assessment of Green Innovation and Open Innovation. The article was submitted to the *Creativity and Innovation Management* journal and it is currently going through the review process.

Keywords: innovation management, circular economy, green innovation, open innovation, corporate sustainability, resource-based theory

5.1 Introduction

While the world is facing escalating environmental concerns and resource depletion, circular economy (CE) is emerging as a pivotal paradigm to achieve sustainable development. In lieu of the take-make-use-dispose linear production and consumption system, it entails a renewable approach that prioritizes waste reduction, resource efficiency, and perpetual material utilization within a closed loop (Bocken et al., 2016; Ellen MacArthur Foundation, 2013; Geissdoerfer et al., 2017; Marsh et al., 2022). As a result, CE gained traction among scholars, practitioners, foundations, and policymakers, due to its potential in sailing global growth while prioritising environmental preservation.

Specifically referring to economic organisations, they play a pivotal role in the imperative transition towards a long-term regenerative production and consumption system. Companies may prioritise circular products and processes development, responsible material sourcing, invest in waste management and recycling infrastructure, or educate consumers about sustainable consumption (Blomsma et al., 2019; Brown et al., 2021; Suchek et al., 2021; Perotti, Bargoni, De Bernardi & Rozsa, 2024). By embracing circularity, firms can effectively pursue economic growth preventing resource depletion and environmental harm, ensuring longevity and regeneration of materials, and ultimately fostering a sustainable and resource-efficient global economy. However, there is an important gap between the growing debate about CE in business management and the actual performance of the world economy. According to the Circle Economy report 2024 (Circle Economy, 2024), the earth can no longer cope with the increasing consumption of virgin materials and waste production, while the amount of resources cycled back into the production system is constantly decreasing. Barely 7.2% of global production was recognised as circular in 2023, compared to 9.1% registered five years ago. Supranational organisational and policymakers are also stressing the need to revise traditional business models to deal with grand challenges such as climate change, resource scarcity, environmental corruption, waste management, biodiversity loss, food security and nutrition (European Commission, 2020; FAO et al., 2022; United Nations Environment Programme, 2024a,b). In summary, there are still many critical issues and barriers hindering CE

implementation. A clearer approach to take the first steps towards the circular transition is sorely needed by companies, while harnessing innovation management may represent a promising approach.

Despite the novelty of innovation management in the CE debate, it offers an interesting insight into the strategic decisions that direct innovation activity in support of circular practices development. According to the resource-based theory (Barney, 1991; Grant, 1991; Wernerfelt, 1984), previous studies highlighted as the relationships between innovation strategy and firm performance is based on accessing critical resources (Ahmed et al., 2020; Martín-Peña et al., 2023; Terziovski, 2010). Such a perspective suggests as companies can leverage innovation management to develop or gather critical resources, specialised expertise, or capabilities to overcome CE barriers. In detail, companies may leverage on green innovation as an attempt to internally develop such critical resources (Awan et al., 2021; Chen, 2008; Shahzad et al., 2021), as well as engaging in open innovation strategies to source them from stakeholders (Brown et al., 2021; Köhler et al., 2022; Perotti, Bargoni, De Bernardi & Rozsa, 2024). Overall, innovation management plays a critical role in achieving sustainability aiming at renewable production and consumption systems, coherently with CE principles about utilizing resources, minimizing waste, and reshaping consumption patterns. Properly harnessing innovation management may allow companies to capitalise on critical resources and develop circular-oriented innovations, which constitutes the linchpin in advancing the CE transition. Through strategic product design and development, these innovations prioritize durability, reparability, and recyclability, aligning with the circular model's sensibility on resource efficiency and waste reduction. However, we can recognise a gap between innovation management and CE. Where previous case studies and systematic reviews supported the relationship between different innovation strategies and CE in businesses, a clear picture is still missing. There are no studies that have directly related these two phenomena. Therefore, bridging this gap would allow academics and practitioners to uncover uncharted avenues and contribute novel insights crucial for effectively harnessing the potential of innovation management to endorse narrowing, closing, and slowing practices implementation in companies. Considering how harnessing innovation may offer a path for businesses towards the circular transition, the present study is based on the following research

question: *how to steer innovation management in companies to take the first step towards the circular transition?*

In response, this study unveils how CE implementation in companies can be facilitated by initially undertaking green innovation – in terms of an innovation approach aimed at building internal capabilities and know-how from the integration of sustainability principles in product, process, and organisational innovation – demands further explanation. The present research thus proposes to assess the nexus between green innovation, particularly concerning products and processes, and the adoption of CE practices in businesses. It also takes into consideration the openness of innovation processes as a favourable condition that fosters the CE principles adoption by heterogeneous companies. In response to the call of previous authors (e.g. Bocken & Ritala, 2021; Brown et al., 2021; Jesus & Jugend, 2023; Kaipainen et al., 2022), this article is meant to address the lack of empirical research about innovation management besides CE initiatives. As one of the earliest studies pursuing theory testing, we collected data from managers of European companies to assess the aforementioned relationship and deliver a clearer picture of innovation management in the CE domain.

Rooted in the resource-based view of the firm (Barney, 1991; Wernerfelt, 1984), the present study delivers some important contributions to theory by advocating innovation management as a feasible strategy to support the CE transition in companies. More precisely, we build on the natural-resource-based view (Hart, 1995; Hart & Dowell, 2011) to understand the critical role of the natural environment in driving business innovation, in addition to relying on the stakeholder-based view (Barney, 2018; Freeman et al., 2021) to acknowledge stakeholder relationship as a strategic resource in achieving sustainable development. We thus support as academics would need such a comprehensive theoretical perspective to appreciate innovation management in businesses, in terms of green innovation and open innovation as antecedents of CE implementation. As a result, we enrich the literature at the intersection of innovation management and CE by offering generalisable findings in support of previous studies. The present article also delivers some practical implications to managers by suggesting how to more the firsts stamps toward CE.

After the introduction, the article is organised as follows. In the second section, a painstaking presentation of the theoretical underpinnings and a literature review progressively lead the reader towards the statement of the hypotheses. The research

design is then presented in section three, before showcasing the results of the data analysis in section four. A thoughtful discussion follows, with specific reference to the theoretical contributions and practical implications delivered by the study. In conclusion, an examination of the research limitations and some insights for future avenues complete the article.

5.2 From theoretical background to hypothesis development

In order to understand the theoretical underpinning of this article and appreciate the hypothesis development, it is necessary to delve into the resource-based view of the firm. Discussing the revamped conceptualisation of this theory, which points out the strategic management of internal resources, environmental constraints, and stakeholder interaction for sustainable development, we offer a comprehensive review of the literature intended to bridge innovation management and CE domains.

5.2.1 Theoretical underpinnings and literature review

In the attempt to establish and sustain a long-term competitive advantage, the resource-based view institutionalised the function of companies' internal assets in driving a firm's strategy (Grant, 1991). Such theory builds on identifying, developing, and leveraging unique resources and capabilities to achieve better performance than competitors (Barney, 1991; Wernerfelt, 1984). When applied to understanding innovation mechanisms in businesses, the resource-based theory offers insights into how economic organisations acquire, develop, and exploit resources to drive innovation. Hence, several academics relied on these theoretical lenses to dwell on innovation management. Previous studies accordingly established the association between innovation strategy and firm performance on critical resources (e.g., Ahmed et al., 2020; Martín-Peña et al., 2023; Terziovski, 2010), along with debating about innovation mechanisms' openness where companies draw on external critical resources and knowledge to address product and process innovation (e.g., Bertello et al., 2022; Brettel & Cleven, 2011). Notwithstanding, the original resource-based view remains somewhat narrow when considering elements beyond the company's boundaries, such as environmental issues and stakeholder interaction (Bouguerra et al., 2023; Freeman et al., 2021; Marín-Idárraga et al., 2016; Vanhaverbeke & Cloodt, 2014).

As an extension of this theory, Hart (1995, p. 991) recognised in advance how "businesses will be challenged to create new concepts of strategy, and it seems likely that the basis for gaining competitive advantage in the coming years will be rooted increasingly in a set of emerging capabilities such as waste minimization, green product design, and technology cooperation in the developing world". Thus, the author proposed the natural-resource-based view of the firm to overcome the original limits of the theory by including the natural environment in corporate strategy. Based on this reconsideration of the resource-based view, business management for competitive advantage is shown to be also rooted in resources and capabilities that promote environmentally and socially sustainable economic organisations (Dangelico et al., 2013; Hart & Dowell, 2011). Accordingly, innovation management studies drew on this theoretical standpoint to ascertain how the combination of internal resources and capabilities, integrated with the natural environment's constraints, may result in economic and environmental value creation. Previous studies dwelled on businesses inclination to innovate product and processes by advancing solutions in terms of green innovation (Andersen, 2021; Cheng, 2020; Makhloufi et al., 2022; Tang et al., 2018; Yahya et al., 2021), sustainability-oriented innovation (Harsanto et al., 2024; Troise et al., 2021), and environmental innovation (Bouguerra et al., 2023; Coppola et al., 2023; De Stefano et al., 2016). As a result, the extension of the resource-based theory advanced by Hart (1995) laid the groundwork to understand innovation mechanisms in companies willing to engage in corporate sustainability.

The natural-resource-based view is also effective in foreseeing companies' attempt to innovate through collaborative approaches (Miemczyk et al., 2016; Rodriguez et al., 2002); which are intended to tackle pollution, ensure product stewardship, and achieve corporate sustainable development (Hart, 1995; Hart & Dowell, 2011). For instance, Andersen (2021) considered the role of green suppliers in strengthening product innovation, while Cheng (2020) discussed green suppliers' involvement as knowledge sources and co-creators in driving green innovation performance. Dangelico et al. (2013) focused on external integrative capabilities, in terms of network collaboration, knowledge link establishment, and know-how acquisition for integrating environmental attributes in green product design and manufacturing. Following this thread, Bogers et al. (2020) and Behnam et al. (2018) supported how open innovation mechanisms can enhance sustainability-oriented innovation development. Therefore, in line with the innovation

management literature, to understand how companies innovate to cope with the external environment, as well as to appreciate how organisations come together to achieve corporate sustainability, just considering environmental constraints affecting the company is not enough. Stakeholders' interaction and exchanges with the firm also demand to be properly rationalised, in a logic of achieving sustainable business development.

As highlighted in the empirical studies of Bouguerra et al. (2023) and Perotti, Bargoni, De Bernardi and Rozsa (2024), the natural-resource-based-view demands further integration to rationalise collaborative behaviours triggered by environmental issues so as to fully comprehend the occurrences of stakeholders' interaction. Addressing this void, the present study relies on Barney (2018) and Freeman et al. (2021)'s recent conceptual endeavours that introduced the stakeholder-resource-based view of the firm. Drawing on the stakeholder theory's influence, which bases strategic management on building and maintaining mutually profitable relationships with stakeholders (Freeman, 1984; Freeman et al., 2010), Barney (2018, p. 3314) recognised that "the ability to generate economic profits often requires access to critical resources from several stakeholders". In this vein, the stakeholder-resource-based view contextualises inter-organisational collaboration by recognising the role of external actors and acquirable resources in shaping a firm's sustained competitive advantage (Barney, 2018; Harrison et al., 2010). Including the stakeholder perspective, this further extension of the resource-based theory frames open innovation strategies as businesses attempt to exploit external actors' proximity to feed innovation processes and drive sustainable development.

As a result, the resource-based theory – declined in the two extensions encompassing the influence of the natural environment and stakeholders' involvement – provides a comprehensive background to investigate how companies exploit internal or external resources and knowledge to achieve a greater sustainability degree and thrive in nowadays markets (Bouguerra et al., 2023; Chaudhuri et al., 2022; Coppola et al., 2023; Yahya et al., 2021). Building on these theoretical premises, the present research addresses the topic of innovation management in driving CE practices implementation in businesses by leveraging green innovation practices and open innovation mechanisms.

In brief, CE offers a sustainable alternative to linear production and consumption models, encompassing responsible business innovation intended to minimize

resource usage, energy consumption, and waste generation (Bocken et al., 2016; Geissdoerfer et al., 2018; Hina et al., 2023). Such construct delves into businesses transition towards closed-loop systems, promoting practices such as long-lasting product design, remanufacturing, reuse, repair, and recycling to maximize the lifespan of goods while making efficient use of resources (Lüdeke-Freund et al., 2019; Perotti, Dhir, Ferraris & Kliestik, 2023). Accordingly, strategically orienting innovation processes is pivotal in overcoming the several technical, technological, and organisational barriers to the development of circular products, or the establishment of circular processes and practices (De Jesus & Mendonça, 2018; Guldmann & Huulgaard, 2020; Hina et al., 2022; Perotti, Bargoni, De Bernardi & Rozsa, 2024). Properly managing innovation allows to come up with new ideas, technologies, processes, products, or business models that are aligned with CE principles. In this vein, previous authors explored the concept of circular-oriented innovations to identify specific forms of innovations that aim to redesign products, services, or processes to downsize waste, improve resource efficiency, and prolong goods exploitation by reusing, repairing, refurbishing, remanufacturing, or recycling practices (Blomsma et al., 2019; Brown et al., 2019; Julkovski et al., 2023). For instance, process and product innovation may allow companies to minimize waste and optimize resource exploitation by maintaining products, components, and materials in active use for an extended period, as well as advancing ad-hoc strategies to reuse or remanufacture exhausted products, and recover or recycle their components (Blomsma et al., 2019; Franzò et al., 2021; Hopkinson et al., 2018).

In the attempt to build on extant theory, we examine two constructs from the innovation management literature to assess how they affect the circular transition of companies. First, we introduce how pursuing green innovation is a favourable condition that contributes to fostering CE implementation (Awan et al., 2021; Khanra et al., 2022; Singh et al., 2020). Approaching green innovation would require a solid base of internal capabilities and resources that can facilitate circular practices implementation, as a result of companies' business strategy alignment with environmental issues while pursuing competitive advantage in dynamic markets (Albort-Morant et al., 2016; Chen, 2008; Coppola et al., 2023; Kaipainen et al., 2022). However, CE integration in businesses requires not only internal resource optimization but also effective collaboration with stakeholders and integration considering environmental influence (Bouguerra et al., 2023;

Dangelico et al., 2013; Perotti, Bargoni, De Bernardi & Rozsa, 2024). Therefore, we advance the influence of open innovation strategies adoption in easing CE practices implementation for circular process establishment and circular product development (Fontoura & Coelho, 2022).

5.2.2 Harnessing green innovation to pave the way for circularity

Green innovation – also appointed as sustainable innovation, eco-innovation, or environmental innovation – can be described through new hunches that shape innovative products, processes, or business practices, while aiming to address environmental and sustainability challenges (Cheng, 2020; Schiederig et al., 2012; Takalo et al., 2021). Such specific innovations are designed to minimize negative externalities on the environment, promote resource efficiency, reduce pollution, and enhance corporate sustainability. In this vein, companies pursue innovation for green products and processes development to achieve a more sustainable and ecologically balanced business while pursuing economic growth (Chang, 2011; Chen et al., 2006; Fontoura & Coelho, 2022). Based on the natural-resource-based view of the firm (Hart, 1995; Hart & Dowell, 2011), green innovation can thus be identified as a means to include environmental constraints in production and organisational activities, which implies firm's resources reconfiguration to seek sustainable development (Andersen, 2021; Rodriguez et al., 2002).

In the CE domain, green innovation has been questioned as an element that contributes to driving circular transition (De Jesus et al., 2018; Kiefer et al., 2021; Sehnem et al., 2022; Schultz & Reinhardt, 2022), to eventually solve grand challenges such as climate change (Durán-Romero et al., 2020; Liu et al., 2024). Their effective relationship remains blurred in literature, however. Triguero et al. (2022) paved the way towards CE by studying some internal and external influencing factors of the firm associated with the implementation of technological breakthroughs concerning reduce, recycle, and redesign practices. In addition, Bag et al. (2022) supported the tie between green supply chain management and CE capabilities in SMEs, including coercive, normative, and mimetic pressures on businesses eco-innovation as antecedents. Although Kiefer et al. (2021) attempted to look into the relationships between different eco-innovation features and CE, the authors coherently found limited significant values especially in conjunction with systemic eco-innovations. Previous studies also advanced the mediating role of green innovation on human resource management practices and CE

performance (Khan et al., 2023), or attempted to conceptually address the link between eco-innovations and CE (Pichlak & Szromek, 2022; Ul-Durar et al., 2023). In sum, despite literature acknowledges a potential link between these two phenomena, the nexus of green innovation and CE still necessitate clarification. More precisely, a research gap exists considering how their straight relationship has been overlooked or taken for granted. Referring to green innovation as an approach that involves internal capabilities and know-how building from the integration of sustainability principles in product, process, and organisational innovation (Albort-Morant et al., 2016; Chen, 2008; Ma et al., 2022); its role in fostering CE implementation in companies demands further explanation.

Following the approach of previous authors (e.g., Chang et al., 2011; Tang et al., 2018; Xie et al., 2019), green innovation is understood in terms of green product innovation and green process innovation. In this vein, we propose how attempting to develop such environmentally friendly breakthroughs enables companies to acquire critical resources, know-how, and capabilities that may, subsequently, facilitate the CE transition. Coherently with our reasoning, Chen (2008) demonstrated that green product and process innovation's success is strictly related to the development of "green core competences", while Albort-Morant et al. (2016) assessed the positive relationship between dynamic capabilities and green innovation performance. More specifically, Ma et al. (2022) considered green dynamic capabilities and knowledge sharing as antecedents to successfully advance green innovations. Following this thread, Khanra et al. (2022) also outlined how engaging in green innovation leads companies to develop specific strategic resources. Relying on such previous contributions, we argue that engaging in green innovation might eventually support CE implementation (Miemczyk et al., 2016; Triguero et al., 2022; Sehnem et al., 2022).

Specifically referring to green product innovation, it involves reengineering or modifying products to be more environmentally friendly throughout their lifecycle. In this vein, approaching green product innovation leads companies to develop advanced design and manufacturing competencies, which might enable the subsequent implementation of remanufacturing and refurbishing practices more effectively (Moroni et al., 2022; Sarkar et al., 2022; Zhang et al., 2019). Additionally, challenging the selection of raw materials and resource efficiency may reasonably prepare companies to undertake recycling and waste recovery programmes for end-of-life products, besides attempting to extend durability and

longevity (Den Hollander et al., 2017; Mignacca et al., 2020; Zhu et al., 2010). As a consequence, we propose that engaging in green product innovation represents an antecedent to implementing CE practices within economic organisations.

HP1: Green product innovation is positively associated with circular economy implementation in businesses.

Regarding green process innovation, it involves modifying or optimizing a company's transformation processes and operations to stem negative externalities and environmental harm. Accordingly, previous studies supported as pursuing green process innovation encourages companies to adopt new practices, cleaner technologies, or revise physical processing to minimise waste, emissions, and energy consumption (Chen et al., 2006; Khan, Kaur, Jabeen, & Dhir, 2021; Liu et al., 2024; Tariq et al., 2017). Here, knowledge and capabilities development also plays a key role in fuelling the related innovation and sustainability performance (Albort-Morant et al., 2016; Shahzad et al., 2020). In practice, innovating manufacturing processes or advancing collection and disposal practices of end-of-life products may lead companies to enhance their capacity for resource recovery, improving their familiarity with closed-loop mechanisms (Perotti, Dhir, Ferraris & Kliestik, 2023). Pursuing sustainable development, economic organisations build on internal capabilities, knowledge, and physical assets by facilitating the translation of CE principles into feasible activities (Bag et al., 2022; García-Quevedo et al., 2020). As a result, we advance the following hypothesis.

HP2: Green process innovation is positively associated with circular economy implementation in businesses.

5.2.3 Enhancing circular economy implementation: the moderating role of open innovation

Open innovation embodies a collaborative approach to innovation based on shared ideas, technologies, and resources with partners, suppliers, public entities, customers, and sometimes even competitors; intended to harness deficient internal ideas or leverage external resources and expertise through joint innovation activities (Chesbrough, 2003; Chesbrough & Bogers, 2014; Enkel et al., 2009). Previous studies observed such a phenomenon alongside corporate sustainability and acknowledged its great potential towards achieving sustainable development (Bertello et al., 2023; Bogers et al., 2020; Camilleri et al., 2023; Ghisetti et al.,

2015). Specifically looking at the CE literature, open innovation mechanisms appear to be related to the implementation of sustainability-oriented innovations with the potential to address major barriers to circular transition.

In the conceptual article advanced by Bocken and Ritala (2021), the authors outline that circular business models can arise from innovations developed in closed or open environments. Based on several interviews with firms and industry experts dealing with the CE transition, Schultz and Reinhardt (2022, p. 1646) coherently recognized that barriers to eco-innovation are mainly related to the firm level, while drivers "primarily manifest beyond immediate industrial boundaries". As a consequence, more and more scholars are delving into the potential of open innovation strategies to exploit external drivers while coping with challenges at the business level. In this vein, Jesus and Jugend (2023) systematised and advanced the literature debate about open innovation along with CE practices, demanding further clarification of resource-based dynamics from a stakeholder viewpoint. Attempting to unveil how inter-organisational collaboration supports the CE transition, Köhler et al. (2022) inquired about open innovation along with dynamic capabilities in a single case study. Building on previous findings, Perotti, Bargoni, De Bernardi & Rozsa (2024) subsequently explored two circular networks leveraging grounded theory to assess how open innovation mechanisms are the basis of a circular supply chain and a circular ecosystem. The authors recognised some substantial differences in the two collaborative approaches but, in both cases, collaboration with stakeholders provided access to physical resources, capabilities and specialised know-how that shaped the circular innovations. In support of the foregoing, Sgambaro et al (2024) also deepened stakeholder collaboration based on open innovation strategies as a CE transition facilitator, offering a value chain perspective from the building industry. In summary, previous inductive studies recognised stakeholder collaboration's support in shaping circular-oriented innovations (Brown et al., 2019; Johnson, 2022; Tapaninaho & Heikkinen, 2022; Triguero et al., 2022). It is still necessary to make a settlement of the actual relationship between open innovation and CE, however. We can recognise a clear gap in effectively measuring whether or not inbound and outbound strategies can feed innovation management and affect CE implementation in economic organisations.

Drawing on the stakeholder-resource-based perspective (Barney, 2018; Bouguerra et al., 2023; Freeman et al., 2021), we support the relationships with stakeholders

as critical assets that can provide the firm with unique capabilities and benefits. In fact, CE typically entails cross-sectoral collaboration fuelled by a multi-stakeholder approach to leverage resource exchange and knowledge sharing by establishing a sustainable advantage (Brown et al., 2021; Hazen et al., 2021; Köhler et al., 2022; Perotti, Bargoni, De Bernardi & Rozsa, 2024). Firms' internal resource base is thus propelled by engaging in open innovation, as research and development cross-boundary initiatives focused on mutual support to overcome technical barriers in circular product and process development (Awan et al., 2021; Chesbrough & Bogers, 2014; Bertello et al., 2023; Strazzullo et al., 2022). In this vein, open innovation seems to be a suitable strategy to address the complexity and aggregated nature of grand challenges, as well as to foster the shift to a renewable production and consumption model. In line with our theoretical standpoint, relationships with stakeholders represent a strategic resource for the company while addressing green innovations, influencing internal asset reorganisation. The internal learning process and knowledge acquisition that occurs when a business approaches green innovations are further emphasised wherever critical resources are also acquired from the external environment (Arfi et al., 2018; Kim et al., 2024; Sun et al., 2023; Wu & Li, 2020). As a consequence, open innovation strategies allow companies to capitalise on their resource set gathering additional elements from external actors, which, in turn, would facilitate their circular transition. In their case study analysis, Bogers et al. (2020) and Perotti, Bargoni, De Bernardi & Rozsa (2024) provide empirical evidence of how open innovation mechanisms can lead to product and process sustainable innovation. The interaction between economic and non-economic realities, characterised by different backgrounds and industries, allowed to tackle technical barriers to green innovation by gathering critical know-how, capabilities, and resources.

Based on these premises, we posit how open innovation can strengthen green innovation positive relationship with CE implementation. Whereas approaching green product and process innovations allows the firm to acquire key resources that would facilitate a potential circular transition, acquiring additional assets from the external environment through open innovation mechanisms would further enrich the company's resource set. By collaborating with external partners, companies can gain access to recovered resources, advanced sustainable materials, and eco-friendly technologies that enhance green product innovation. Additionally, engaging in collaborative innovation may lead to introducing new physical

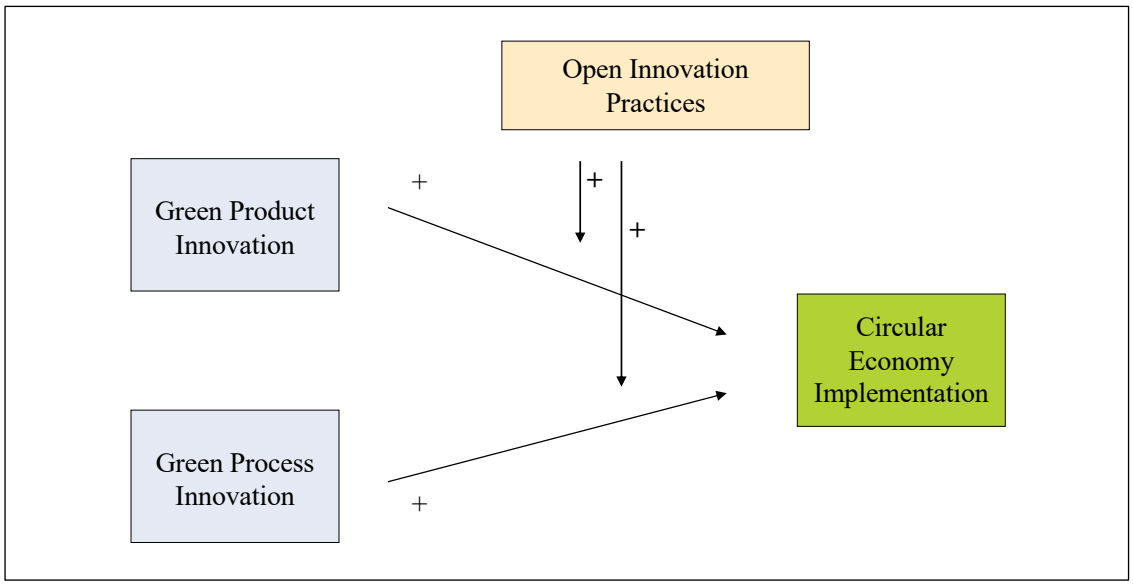
processing techniques or best practices for green process innovation, streamlining transformation processes and reducing waste. As a result, an organisation would find even more elements among their internal assets that may accelerate a subsequent CE transition. According to our reasoning, the following hypotheses are advanced below.

HP3a: Open innovation practices positively moderate the association between green product innovation and circular economy implementation.

HP3b: Open innovation practices positively moderate the association between green process Innovation and circular economy implementation.

In conclusion, Figure 12 represents the conceptual model that resumes the advanced hypotheses.

Figure 12. The conceptual model



Source: Authors' elaboration.

5.3 Research design

5.3.1 Sampling and data collection

In the form of a cross-sectional study, we adopted nonprobability sampling to collect data from managers employed in more than 350 heterogeneous for-profit organizations in Europe (see Table 1). Choosing individuals holding managerial positions as respondents ensures information gathering from subjects characterised by an overall view of the company's managerial decisions, processes, and innovation strategies (Santoro et al., 2018; Song et al., 2024). More specifically,

we targeted people who have held a managerial position in their current company for at least three years. In light of previous studies (e.g. Khan, Daddi & Iraldo, 2021; Khaw et al., 2023; Singh et al., 2020), they represent an ideal sample to obtain information about innovation management processes and CE principles adoption by companies.

In order to prevent potential biases due to constructs self-assessment, we took some precautions. Potential systematic biases related to data collection have been mitigated by relying on a number of observations coherent with structural equation modelling techniques from randomised individuals, as well as maintaining a representative distribution of observations (Dash & Paul, 2021; Hair et al., 2019; Short et al., 2002). Furthermore, several precautions were taken while designing the survey and during data analysis to ensure the measurement model's validity and reliability.

Table 10. Characteristics of the sample

Category	Characteristic	Frequency	Percentage
Company size	Small	120	37.7%
	Medium	71	22.4%
	Large	127	39.9%
Industry	Aerospace	1	0.3%
	Agriculture	7	2.2%
	Automotive	2	0.6%
	Aviation	1	0.3%
	Chemical	4	1.3%
	Construction	11	3.5%
	Design and engineering	7	2.2%
	Education	11	3.5%
	Entertainment	5	1.6%
	Finance	17	5.3%
	Food & beverage	4	1.3%
	Health and fitness	12	3.8%
	Hospitality	13	4.1%
	Information technology	34	10.7%
	Insurance	4	1.3%
	Legal	2	0.6%
	Manufacturing	55	17.3%
	Marketing and communication	12	3.8%
	Pharmaceutical	3	0.9%
	Real estate	3	0.9%
	Retail	23	7.2%
	Services	44	13.8%
	Software development	7	2.2%

	Telecommunications	5	1.6%
	Textile and fashion	2	0.6%
	Transport and logistics	25	7.9%
	Utilities	4	1.3%
Country	Austria	6	1.9%
	Belgium	4	1.3%
	Croatia	6	1.9%
	Czech Republic	6	1.9%
	Denmark	10	3.1%
	Estonia	7	2.2%
	Finland	10	3.1%
	France	12	3.8%
	Germany	26	8.2%
	Greece	24	7.5%
	Iceland	5	1.6%
	Ireland	9	2.8%
	Italy	34	10.7%
	Luxembourg	3	0.9%
	Norway	10	3.1%
	Poland	34	10.7%
	Portugal	35	11%
	Romania	6	1.9%
	Slovenia	4	1.3%
	Slovakia	16	5%
	Spain	18	5.7%
	Sweden	6	1.9%
	Switzerland	4	1.3%
	The Netherlands	10	3.1%
	United Kingdom	13	4.1%

Source: Authors' elaboration.

5.3.2 Survey design

During the data collection planning phase, we implemented various precautions in survey design to ensure reliable and rigorous empirical observations. Variables measurement was defined in accordance with previous reputed contributions about data collection techniques, as well as previous studies dealing with the CE and innovation management domain.

First, concerns pertaining to data collection and plausible respondents' negligence or prejudice were minimised by scrupulously revising items' wording, in addition to including attention check questions and reverse-coded items (DeVellis & Thorpe, 2021; Fink, 2002a; Fink, 2002b; Martin, 2006). According to Podsakoff et al. (2003), indeed, the risk of potential biases can be minimized by checking for

wording ambiguities and or potential comprehension issues from the initial stage of questionnaire designing.

Secondly, the questionnaire utilized a structured approach incorporating multiple items to ensure the reliability and validity of the survey (DeVellis & Thorpe, 2021; Peter, 1979; Zikmund and Babin, 2016). Variables were assessed using a five-point Likert Scale to gauge interviewees' level of disagreement or agreement with the provided statements (i.e., from 1 “Strongly disagree” to 5 “Strongly agree”). In particular, each construct was measured through variables already assessed by previous studies, whose items have been revised to suit researcher purposes in the present study (see Appendix). Green product and process innovation were measured by drawing on constructs and items proposed by Wong et al. (2020). More specifically, green product innovation was measured by observing companies’ innovations in terms of product (or service) design and packaging (or service delivery conditions), while green process innovation was assessed by innovation attempts concerning sourcing, operations, and logistic processes. Then, we assessed open innovation practices’ adoption by companies (i.e., outside-in, inside-out, and coupled activities) relying on the scale developed by Cheng and Huizingh (2014), who offered a valuable means to assess such phenomena in companies. Finally, CE implementation was observed by combining and adapting the two measurement scales, advanced by Di Maria et al. (2022) and Khan, Daddi and Iraldo (2021). While the first study purely introduced seven new items, the second one developed another measurement scale based on a partial adaptation of Zhu et al. (2010) and coming up with additional items. As a result, we developed a comprehensive variable that enabled us to appraise the extent to which companies implemented CE practices, specifically achieving input and production waste reduction through narrowing, slowing, and closing strategies.

In addition, the survey was properly structured by arranging independent and dependent variables within the questionnaire to avoid demand and cognitive biases. We also clearly guaranteed the answers' confidentiality and respondents anonymity (Schmidt et al., 2023). Besides precautions taken by us while designing the survey, the overall design of the questionnaire was finally revised by experts among scholars and practitioners to ensure measurement scales’ face and content validity (Fink, 2002b). This process further ensured the rigour of the measurement instrument employed in the study.

5.3.3 Data analysis and tools

Based on recent studies on the topic of CE (e.g. Chang, 2011; Yu et al., 2022), we decided to assess the advanced hypotheses by a covariance-based structural equation modelling (CB-SEM) technique. Such a data analysis method allowed the researchers to simultaneously evaluate any potential link among the observed variables through visual representation and model validation. CB-SEM was preferred to other methods due to its nature suitable for theory testing and confirmation. Previous studies (e.g. Dash & Paul, 2021; Hair et al., 2017; Hair et al., 2019) recognised it as the most appropriate data analysis method for validating or refuting theories, considering research based on a deductive approach to theory building.

After data collection, data cleaning and processing were administered recurring to the IBM software SPSS Statistics (v.29). It was employed to obtain descriptive metrics and determine correlations among variables, besides assessing data's normal distribution, multicollinearity issues absence, and identifying potential common method variance in responses. At a later stage, the assessment of the structural path's validity and reliability, as well as the hypotheses validation, were performed by the IBM software SPSS AMOS (v.29).

5.4 Result of the analysis

At the end of data collection, we gathered 354 answers from the survey. In an initial screening, 32 responses were rejected because incomplete or when respondents failed the attention check questions. Then, 4 responses showing extreme response bias were excluded as outliers. This process aligns with guidelines from past studies to ensure the findings' validity and reliability (Ghosh & Vogt, 2012; Hawkins, 1980). As a result, 318 valid records were considered for examining the goodness of the data.

5.4.1 Data diagnostics: normality, common method bias, and multicollinearity

Data eligibility was evaluated by performing diagnostic checks, which included the assessment of data distribution normality, common method bias, and multicollinearity effect. First, as CB-SEM rely on maximum likelihood estimator to assess the parameters of an assumed probability distribution, it is necessary to assess the normal distribution of data to prevent the accuracy of parameter

estimates from being affected and standard errors. Data normality was observed through skewness and kurtosis values, in addition to assessing Kolmogorov-Smirnov and Shapiro-Wilk values' significance. Accordingly, the study can rely on normal data distribution due to skewness and kurtosis values falling under the advised thresholds of -2/+2, besides ascertaining the other indicators' significance (Hair et al., 2019; George & Mallery, 2018).

Next, since the survey approach to data gathering exposes the measurement model to common method bias, we had to ensure that the variance in the data was actually attributable to the constructs measured rather than the data collection method. In order to minimise the risk of measurement inaccuracies, the absence of common method variance was assessed by loading all the items in a common factor to prevent any potential effect due to standard method bias (e.g. Perotti, Belas, Jabeen & Bresciani, 2023; Schmidt et al., 2023). Following the procedure advanced by Harman (1976), resorting to the Harman's single factor allowed us to observe the cumulative squared variance percentage amounted to 33,83%, which is lower than the 50% suggested threshold (Podsakoff et al., 2003; Podsakoff et al., 2012). This outcome indicates that the present study does not face any common method variance-related measurement concerns.

Finally, the linear relationship between the independent variables has been also examined to prevent overfitting issues and concerns regarding the accuracy of the model's parameter estimates. As a result, we assessed the absence of multicollinearity by looking at the variance inflation factors (VIFs), which registered values below 2.3 and a tolerance exceeding 0.40 (Alin, 2010; Perotti, Belas, Jabeen & Bresciani, 2023; Tandon et al., 2022). Upon evaluating data eligibility, we were legitimised to move forward with the confirmatory factor analysis (CFA) and hypothesis testing.

5.4.2 Measurement validation assessment

Measurement model validity and reliability were validated by advancing a CFA, since the observed variables draw on well-established constructs advanced in previous studies (Hair et al., 2019; Kline, 2023). At first, according to the relevant literature (Bentler & Bonett, 1980; Hu & Bentler, 1998; MacCallum et al., 1996; Marsh & Hocevar, 1985; Kline, 2023), we went through an evaluation of the model fit that returned satisfying values: PCMIN/DF = 1.883; CFI = .915; TLI = .904; RMSEA = .053. Then, we evaluated construct convergent validity through the

revelation of each factor loading and variables' average variance extracted (AVE); besides comparing such outcomes with factors correlation values and their respective statistical descriptors to evaluate discriminant validity. In parallel, the integrity of the measurement method has been further questioned by observing the composite reliability (CR) values of each variable. Table 11 showcases how the majority of items load acceptably to their respective variable, except for two items (i.e. CLS4 and CLS5). They were excluded since the standardised loading factors reported values lower than .6. Thereafter, both AVE and CR results align with the threshold recommended in previous studies regulating the methodology adopted in this research (Hair et al., 2019; Kline, 2023; Zikmund & Babin, 2016).

Additionally, Table 12 reports the extent to which one metric differs from another whose foundational concept is not inherently connected to it. It can be observed that all constructs and their corresponding variables adhere to discriminant validity benchmarks, given that the square roots of AVE (highlighted in Table 11) are consistently greater than the correlation coefficients of the latent construct for every observed variable. All correlation results are notably significant at the .01 level (2-tailed).

In summary, the CFA validated measurement tool appropriateness and confirmed the eligibility of the dataset, which enables the researchers to advance to hypothesis testing.

Table 11. Factor analysis for convergent validity and construct reliability

Variable	Item	Standardized Factor Loading	Average Variance Extracted (AVE)	Composite Reliability (CR)
Green Product Innovation (GProdInn)	DES1	0.788	0.689	0.952
	DES2	0.738		
	DES3	0.874		
	DES4	0.876		
	DES5	0.769		
	PAK1	0.840		
	PAK2	0.897		
	PAK3	0.898		
	PAK4	0.775		
Green Process Innovation (GProcInn)	SRC1	0.767	0.581	0.938
	SRC2	0.757		
	SRC3	0.833		
	OP1	0.792		
	OP2	0.784		
	OP3	0.714		
	OP4	0.759		

	LGS1	0.685		
	LGS2	0.788		
	LGS3	0.788		
	LGS4	0.702		
Open Innovation Activities (OIA)	OIA1	0.743	0.507	0.925
	OIA2	0.736		
	OIA3	0.753		
	OIA4	0.764		
	OIA5	0.678		
	IOA1	0.653		
	IOA2	0.729		
	IOA3	0.716		
	IOA4	0.677		
	CA1	0.660		
	CA2	0.816		
	CA3	0.596		
Circular Economy Implementation (CEI)	NAR1	0.778	0.561	0.920
	NAR2	0.733		
	NAR3	0.720		
	SLW1	0.741		
	SLW2	0.760		
	SLW3	0.779		
	CLS1	0.846		
	CLS2	0.710		
	CLS3	0.657		
	CLS4	(removed)		
	CLS5	(removed)		

Source: Authors' elaboration.

Table 12. Statistical measures and correlation matrix for discriminant validity

Variable	Mean	Std. Deviation	GProdInn	GProcInn	OIA	CEI
GProdInn	3.552	0.832	**0.830**			
GProcInn	3.448	0.741	0.731**	**0.762**		
OIA	3.571	0.645	0.314**	0.390**	**0.712**	
CEI	3.384	0.754	0.669**	0.698**	0.387**	**0.749**

Note: The bold diagonal values represent respective square roots of average variance extracted (AVE), and ** means that correlations are significant at the 0.01 level (2-tailed).

Source: Authors' elaboration.

5.4.3 Hypothesis testing

After confirming measurement model adequacy, we proceeded with conducting CB-SEM to evaluate the associations among the observed variables. Overall, the hypothesis testing demonstrated that all path coefficient results were statistically significant and well-supported. In detail, our findings report a significant positive

relationship between green product innovation and CE implementation in companies (0.335***), in support of HP1. A significant positive relationship was also reported observing green process innovation and CE implementation (0.472***), supporting HP2. In this vein, the empirical investigation managed to outline the close tie between the pursuit of green innovations and the implementation of circular practices within the company. The structural model shows that a significant variation of the dependent variable is caused by the two independent variables (R2 = 0.644).

This study also explored how the adoption of open innovation strategies can contribute to strengthening the previous advanced relationships. Accordingly, the third hypothesis found support in our data, showing how embracing open innovation strategies positively affects CE practices adoption in the observed companies. More specifically, openness in companies' innovation practices significantly moderates the previously advanced relationships by strengthening the influence of green product innovation and green process innovation on CE implementation. As a consequence, we confirm HP3a and HP3b.

Finally, some control variables have been included to account for potential confounding factors that could influence the relationship between the independent variables and the dependent one. Specifically, we controlled for company size, industry, and country. However, our analysis revealed that none of these control variables exhibited a statistically significant effect on CE implementation. The inclusion of these control variables did not alter the relationships between our independent variables and CE implementation, suggesting that the observed effects are robust across different company sizes, countries, and industries.

Table 13 showcases the result of hypothesis testing.

Table 13. Results of hypotheses testing

Hypothesis	Path	Estimate (β)	Significance (*p*)	R^2	Result
HP 1	GProdInn → CEI	0.335	0.000	0.644	Supported
HP 2	GProcInn → CEI	0.472	0.000		Supported
HP 3a	GProdInn_OIA → CEI	0.503	0.000	-	Supported
HP 3b	GProcInn_OIA → CEI	0.611	0.000	-	Supported

Source: Authors' elaboration.

5.5 Discussion and implications

As a result of our empirical investigation, the present research successfully bridges innovation management and CE. In response to the gaps identified in previous studies that systematised (e.g., Jesus & Jugend, 2023; Sehnem et al., 2022; Suchek et al., 2021) and advanced the literature debate with exploratory inquiries (e.g., Bogers et al., 2020; Köhler et al., 2022; Perotti, Bargoni, De Bernardi & Rozsa, 2024), we offered further clarification through generalisable conclusions based on a deductive approach to theory building.

In the first place, we support how pursuing green innovation provides fertile ground for moving towards CE implementation, in for-profit economic organisations. Complementing previous studies such as Triguero et al. (2022), which questioned some internal and external influencing factors of eco-innovation related to CE practices, this study takes the next step and demonstrates the relationship between green innovation and the effective implementation of circular products and practices. In agreement with Bag et al. (2022), our findings substantiate previous conceptual claims about the relationship between eco-innovations and CE, discussed by Kiefer et al. (2021), Pichlak and Szromek (2022), and Ul-Durar et al. (2023).

In detail, this study advances as firms' attempt to innovate products and processes seeking corporate sustainability leads them to capitalise on their resource and knowledge base (Chen, 2008; Khanra et al., 2022; Ma et al., 2022), facilitating a later integration of CE principles (Khan, Daddi & Iraldo, 2021; Saari et al., 2024; Seles et al., 2022). Specifically referring to green innovation related to product (or service) design and packaging (or service delivery conditions), we complement Den Hollander et al. (2017) and Franzò et al. (2021) in supporting new product development for CE. Furthermore, we substantiate how to effectively achieve new packaging design for CE, as identified by Zhu et al. (2022)'s review or the compostable packaging suggested by the case advanced by Casarejos et al. (2018). By confirming our hypothesis, we also build on green process innovation for CE. The output of this research emphasises how businesses that engage in sourcing, operations, and logistic green innovation tend to implement more successfully circular practices, as the ones suggested by Ranta et al. (2018). It gives also empirical support in terms of sourcing and logistic innovation for CE based on digital technologies, as outlined in Liu et al. (2022) and Perotti, Dhir, Ferraris and

Kliestik (2023)'s studies. Overall, this research further extends the literature debate that considered various forms of environmental innovations and corroborates its relationship with effective CE implementation in companies.

As a second key result, we empirically proved that firms undertaking open innovation strategies further amplify the preparatory role of green innovations in supporting CE implementation. Introducing the positive moderating role of open innovation, we answer the call of previous studies in shedding light on its relationship with CE implementation. Following the recommendation of the systematic reviews advanced by Suchek et al. (2021) and Jesus & Jugend (2023), where the authors respectively suggested to delve into strategic alliances for CE innovations and to further explore the link between open innovation and CE with a deductive approach, we offer empirical validation in that vein. Our findings also substantiate the claims of empirical case studies such as Köhler et al. (2022) and Perotti, Bargoni, De Bernardi & Rozsa (2024), which recognised and depicted open innovation mechanisms in support of CE economy implementation. In addition, Sgambaro et al. (2024) also outlined the key role of open innovation in supporting companies' circular transition in the building industry. Accordingly, we corroborate such an approach to research and development as a facilitator of knowledge, capabilities, critical resources and technology pooling for the development of circular products and processes. Specifically referring to the positive moderating role of open innovation on the relationship between green innovation and CE, we assert how it strengthens and amplifies the benefits of addressing green innovations in terms of enriching the firm's assets base. Pursuing innovations intended to increase the firm's products and processes sustainability, in collaboration with stakeholders, provides access to additional resources and knowledge, as well as enhanced exploitation of in-house endowments (Arfi et al., 2018; Awan et al., 2021; Kim et al., 2024; Sun et al., 2023). In this vein, we support open innovation strategies adoption by also complementing previous studies that considered green or sustainable innovation in the supply chain (Cheng, 2020; Liu et al., 2018; Wu & Li, 2020).

In summary, the present research stands as an original contribution as one of the earliest empirical investigations aimed at testing previously advanced claims in case studies, systematic reviews, or conceptual papers, addressing innovation management in the CE literature stream. In the remainder of the section, a detail

of the contributions and implications delivered by the present study is offered to the reader.

5.5.1 Theoretical contribution

The present research contributes to the advancement of the resource-based theory (Barney, 1991; Wernerfelt, 1984), enriching the literature at the intersection of innovation management and CE. More specifically, we rely on the extensions of this theoretical framework by integrating the natural-resource-based view and the stakeholder-resource-based view, thereby offering a more comprehensive understanding of critical resource management for sustainable development.

Drawing on the natural-resource-based view of the firm (Hart, 1995; Hart & Dowell, 2011), our findings emphasize the critical role of the natural environment in redefining innovation processes. By engaging in green product and process innovations, firms not only align their internal assets with environmental constraints but also lay the groundwork for the successful adoption of circular practices. This reinforces the natural-resource-based view's assertion that sustainable competitive advantage increasingly depends on rare, valuable and inimitable resources that address environmental challenges (Andersen, 2021; Cheng, 2020; Yahya et al., 2021), such as waste minimization and resource efficiency (Coppola et al., 2023; Perotti, Bargoni, De Bernardi & Rozsa, 2024). Our research empirically substantiates the linkage between green innovation and CE, demonstrating that firms leveraging their green capabilities, know-how, and technologies are better positioned to implement circular processes and products, thus contributing to both economic and environmental value creation. Supporting such a theoretical extension of the resource-based theory, which underscores the importance of integrating natural constraint into the strategic management of resources, we further academics understanding of how firms can achieve sustainable competitive advantage.

Furthermore, we build on the stakeholder-resource-based view of the firm (Barney, 2018; Freeman et al., 2021) by recognising the moderating role of open innovation in strengthening the relationship between green innovation and CE implementation. We complement traditional resource-based theory by recognizing the value of accessing critical resources through collaboration with external stakeholders. Our findings provide empirical support for this perspective, demonstrating that firms adopting inbound, outbound, and coupled strategies can

significantly enhance their resource base and capabilities, thereby accelerating their circular transition. This contribution is crucial as it validates the stakeholder-resource-based view's proposition that stakeholder interaction is not merely a peripheral concern but a central element in achieving sustained competitive advantage (Bouguerra et al., 2023; Harrison et al., 2010; Rodriguez et al., 2002), particularly in the context of sustainability-oriented innovations (Bogers et al., 2020; Behnam et al., 2018). By recalling how open innovation facilitates the pooling of resources, knowledge, and technologies from external actors, our study provides a more nuanced understanding of how firms can leverage stakeholder relationships to drive green innovation (Dangelico et al., 2013) and, ultimately, engage in the CE transition (Perotti, Bargoni, De Bernardi & Rozsa, 2024; Tapaninaho & Heikkinen, 2022).

As a result, this research elucidates CE implementation understanding through the theoretical lenses offered by the resource-based theory. By integrating the natural-resource-based and stakeholder-resource-based views, we offer valuable insight into the comprehension of such phenomena in companies through innovation management. In particular, we emphasise how the traditional perspective of this theory may not be enough to comprehend CE implementation in companies, prompting academics to contemplate innovation management and CE from a more comprehensive theoretical angle.

5.5.2 Practical implications

This study offers several insights for managers of companies seeking to succeed in CE transition, as well as respect to policymakers that aim to promote a responsible production and consumption system. First, we suggest managerial figures take action on innovation management to pave the way toward CE adoption. On the one hand, green innovation proved to be a strategic priority for aligning business with environmental constraints, while fostering the development of critical resources, capabilities, and specialised expertise. It may represent an initial step towards sustainable thriving, which allows companies to capitalise on internal strategic assets and overcome barriers to the re-engineering of products and processes with lower environmental footprint. Managers involved in areas related to product or service design and delivery, raw material sourcing, operations arrangement, and logistics administration should thus consider green innovation as a learning opportunity. Gradually approaching it, firms would become familiar

with cost reduction mechanisms, raise the intrinsic value of products or services, and meet consumers' increasing tendency to prefer environmentally friendly products (McKinsey & Company, 2023; PricewaterhouseCoopers, 2024; Reichheld et al., 2023).

On the other hand, we suggest managers deal with green innovation by collaborating with other stakeholders. Firms are encouraged to engage in open innovation establishing strategic alliances, redefining supply chain exchanges, and joining circular ecosystems to capitalise on resource and knowledge sharing. Managers should actively seek opportunities to share resources, waste materials, processing technologies, specialised expertise, technical know-how, or specific competencies across organizational boundaries. Collaboration with external partners such as suppliers, customers, competitors, service providers, research institutes, public entities, and non-profit organisations is essential for accessing complementary critical resources and overcoming barriers against the circular transition.

Overall, the implications delivered by this study are intended to guide strategic decision-making to enhance corporate sustainability and drive CE principles adoption within firms. In the attempt to bridge innovation management and CE, we encourage managers to take the first steps towards renewable and restorative production systems by engaging in green innovation, specifically in collaboration with stakeholders. This allows the company to gradually acquire awareness and key resources that will facilitate the subsequent approach to the circular transition.

In terms of implications for policymakers and public entities, our findings may be useful to inspire public actors to develop ad-hoc initiatives to promote green innovation in businesses. Moreover, they could consider promoting or financing collaborative initiatives intended to stimulate inter-organisational collaborations based on sustainability purposes. Developing policies and initiatives aimed at fostering innovation ecosystems conducive to green and open innovation may be helpful in achieving sustainable development through CE implementation. This includes providing financial incentives, grants, and support programs to encourage inter-organizational collaboration and knowledge exchange among companies, public institutes, research organizations, and other stakeholders. We encourage intensifying initiatives such as the Circular Economy Stakeholder Platform, recently developed by the joint effort of the European Commission and the

European Economic and Social Committee (EESC) as a system designed to bring together stakeholders active in CE in Europe (European Commission, 2023).

5.6 Conclusions and future avenues

The present research has successfully advanced academics and practitioners' understanding of innovation management as a significant driver of CE implementation. Particularly, we emphasise the importance of engaging in green innovation and open innovation to take the first step towards the circular transition. It allows the acquisition of critical knowledge and resources, which facilitate the development of circular products and processes. As one of the pioneering quantitative studies in this field, this research provides valuable insights that can be generalized beyond specific cases.

At the conclusion of the research, we can certainly point out some inherent limitations and suggestions for future studies. In the first place, the cross-sectional nature of our empirical investigation restricts our ability to assess the progressive establishment of circular practices within businesses over time. To address such a limitation, future research endeavours should consider employing a longitudinal approach across a broader sample of companies. This would enable researchers to observe the dynamic progression of CE implementation and the evolving role of innovation management strategies over time. Academics may also consider investigating the specific advantages and disadvantages of open innovation strategies (Greco et al., 2019), shedding light on the benefits and risks faced by companies. Secondly, we recognise a limitation in sampling several industries. Future studies may delve deeper into a specific one, outlining industry-specific differences in manufacturing or service companies' approach to the CE transition. Moving forward, researchers may also dwell on the role of organizational culture and leadership in driving the implementation of CE practices. Understanding how organizational values and leadership styles influence decision-making processes related to sustainability and innovation could provide valuable insights for promoting circularity within businesses. In addition, future studies can further inquire into the impact of regulatory frameworks and policy interventions on the adoption of circular practices. By examining the effectiveness of different policy measures, such as tax incentives, subsidies, and regulatory mandates, researchers can identify proper decisions to incentivize and support firms in their transition

towards CE. Research examining the financial implications of adopting CE practices is required, in conclusion.

5.7 Appendix: Variables measurement and items

Green product innovation

In the last three years, the company where you work has been committed to:

Product/Service design
DES1: Innovating product/service design to decrease the consumption of materials.
DES2: Innovating product/service design to decrease the consumption of energy.
DES3: Innovating product/service design to reduce its environmental footprint.
DES4: Innovating product/service design to minimise the externalities on the environment (e.g. reducing pollution or waste at product end-of-life).
DES5: Innovating product/service design to include secondary raw resources or recycled materials.

Packaging/Service delivery conditions
PAK1: Innovating packaging/service delivery conditions to include recycled materials.
PAK2: Innovating packaging/service delivery conditions to reduce its environmental footprint.
PAK3: Innovating packaging/service delivery conditions by switching to more sustainable materials.
PAK4: Innovating packaging/service delivery conditions by reducing the amount of wrapping.

Green process innovation

In the last three years, the company where you work has been committed to innovating processes by:

Sourcing
SRC1: Sourcing non-hazardous/toxic materials.
SRC2: Sourcing from suppliers who comply with environmental regulations.
SRC3: Sourcing environmentally friendly raw materials (e.g. recycled or recovered secondary raw materials).

Operations
OP1: Monitoring current operations processes to reduce waste from all sources.
OP2: Auditing operations process to reduce waste from all sources.
OP3: Using cleaner technology to decrease waste from all sources.
OP4: Introducing new operations processes to reduce waste from all sources.

Logistics

LGS1: Employing cleaner transportation modes.

LGS2: Improving vehicle fill (or products disposition).

LGS3: Carefully scheduling transportation routes to reduce emissions.

LGS4: Compacting packaging to reduce space requirements.

Open Innovation Activities

With reference to innovation projects undertaken in the last three years by the company where you work, answer the following questions indicating whether you disagree or agree.

Outside-in activities

OIA1: External partners, such as customers, competitors, research institutes, consultants, suppliers, government, or universities are directly involved in all our innovation projects.

OIA2: All our innovation projects are highly dependent upon the contribution of external partners, such as customers, competitors, research institutes, consultants, suppliers, government, or universities.

OIA3: Our firm often buys R&D-related services from external partners, such as customers, competitors, research institutes, consultants, suppliers, government, or universities.

OIA4: Our firm often buys intellectual property, such as patents, copyrights, or trademarks, from external partners to be used in our innovation projects.

OIA5. Our firm invests in other firms because we would like to obtain synergies that are beneficial to our innovation projects (Removed in Cheng & Huizingh, 2014)

Inside-out activities

IOA1: Our firm often sells licenses, such as patents, copyrights, or trademarks, to other firms so as to better benefit from our innovation efforts.

IOA2: Our firm often offers royalty agreements to other firms to better benefit from our innovation efforts.

IOA3. Our firm strengthens every possible use of our own intellectual properties so as to better benefit our firm.

IOA4. Our firm found spin-offs to better benefit from our innovation efforts.

Coupled activities

CA1: In innovation projects, our firm usually integrates all internal and external partners' information.

CA2: In innovation projects, our firm coordinates the activities of information exchange among partners.

CA3: In innovation projects, our firm keeps internal and external partners updated about new information.

Circular Economy Implementation

In the last three years, the company where you work have specifically implemented the following decisions and/or practices.

Narrowing
NAR1: Adoption of more sustainable inputs in product development/service delivery (for instance recycled or recovered materials).
NAR2: Reduction of process-related environmental impact (for example on air or water).
NAR3: Reduction of production waste.

Slowing
SLW1: Employment of firm's waste in the same or other compatible production processes.
SLW2: Design products to be easily repaired/refurbished.
SLW3: Designing products to be easily biodegradable/recyclable.

Closing
CLS1: Adoption of more sustainable inputs in product development/service delivery (for instance recycled or recovered materials).
CLS2: Moving toward greener suppliers.
CLS3: Use of waste from other companies/sectors as input in product development/service delivery.
CLS4: Transferring or selling bi-products to other organizations to avoid waste.
CLS5: Recycling own production waste.

5.8 Reference list

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FINAL THOUGHTS AT THE END OF THIS JOURNEY

After each completed study, several research opportunities open up.

While carrying out my research project, I was attempting to follow a straightforward research path as I glimpsed new trails with every step taken. Sometimes I was satisfied with our direction, while at other times I would have wanted to observe phenomena from a different perspective or question more constructs. Nonetheless, even a research project has its natural end, at the summit of an uphill doctoral journey.

This doctoral dissertation closes a four-year journey but does not represent a conclusion; instead, it is meant to be a foundation for a new beginning. These months of climbing have been beneficial in reaching higher ground, where the haze has (partially) cleared, from which I can see my surroundings more clearly. When I look back, the view is sharper. However, beyond the mist, there are untold other trails, peaks, and goals. Countless possibilities and a great desire to keep moving upward.

From this perspective, I look at the results achieved so far to draw my future research path. This dissertation contributes to the burgeoning literature of corporate sustainability by foregrounding inter-organisational collaboration, open innovation, and digital technologies as instrumental drivers of circular economy adoption. Through rigorous empirical inquiry and drawing on renowned theoretical milestones, I sought to enrich academics and practitioners' understanding of how companies should navigate the complexities of the transition towards a responsible and renewable system, while concurrently pursuing economic, environmental, and social value creation.

Apart from raising such awareness, this dissertation identifies several avenues for future research. Starting from the review of the literature, it clearly highlights the need for more empirical quantitative studies to validate theoretical propositions and offer generalisable findings. Future studies should also delve into the similarities and differences among the various collaborative approaches, providing empirical evidence to guide decision-makers in choosing the most suitable strategies for their specific contexts. This dissertation suggests looking into inter-organisational collaboration dynamics to find answers that would ease businesses' approach to circular economy. Upcoming research might comply with the outlined

literature streams in the circular economy domain, which attempt to shed light on value creation and distribution dynamics, stakeholder engagement and interaction, open innovation strategies, dynamic capabilities, or digital technologies. More specifically, I observed how several opportunities lie beyond the innovation management mechanisms of circularity-oriented companies, with room to question the right degree of internal development and openness to stakeholders. Furthermore, we discovered how digital technologies play different roles in supporting circular product and process development, although we can still question the effectiveness and elaborate on their unknown implications in different collaborative settings.

In conclusion, I am delighted with the achievement of this doctoral journey, but I feel even more enthusiastic about the endless doors left open or ajar. In the coming years, I hope to have the opportunity to open and close as many as possible of them, continuing this wonderful adventure.