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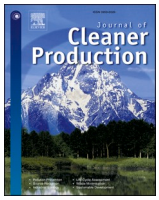

Collaborations for circular food waste management in Italian fish manufacturing firms: A resource dependence perspective

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ABSTRACT

This paper aims to shed light on supply chain collaborations in circular economy for food waste prevention and management. The exploratory study adopts a multiple case study research design on a sample of two polar cases: a small enterprise and a large company in the Italian manufacturing industry of fishery products. Resource Dependence Theory (RDT) allows for an understanding of the mechanisms of circular supply chains, describing strategic motivators of collaborations for circular economy, and overall provides a novel perspective on food waste prevention and management. This study highlights how companies develop in-house solutions when the food waste streams are moderate but rely on collaborations when the streams are conspicuous, thus, the need to implement circular economy solutions fosters collaborations. The findings provide a novel perspective on collaborations in circular economy; furthermore, RDT offers a novel conceptualization of food waste management practices, highlighting the suitability of further applying RDT to this field of study.

1. Introduction

The Food and Agriculture Organization of the United Nations (FAO) estimates that approximately one-third of global food production goes to waste (FAO, 2011). Given the significance of this issue, reducing Food Waste (FW) is crucial for sustainable development and achieving the related Sustainable Development Goal (SDG) 12.3 ("*By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses*" - United Nations, (2015)). FW is considerably higher for highly perishable products, such as fish, with 51.2% of European fishery products wasted annually (Caldeira et al., 2019). The main losses occur during processing, which accounts for 70% of the waste generated along the fish supply chain (SC) (Ghosh et al., 2016; Caldeira et al., 2019; FAO, 2020). The fishing sector plays a significant role in the European economy: in 2020, the EU-27 countries were the seventh-largest producer worldwide, and within the European market, Italy ranks third in fish landings and fourth in aquaculture (EUMOFA, 2022a). Almost 400 companies operate in Italy's seafood processing sector, generating a turnover of 2,1 billion €, and employing over 5500 people (STECF, 2021; EUMOFA, 2022b). These figures highlight the relevance of the seafood processing industry in Italy and Europe and the magnitude of the problem of FW in the sector.

To address the challenge of FW, the Circular Economy (CE) has been widely recognized as a promising approach (Ellen MacArthur Foundation, 2013), offering solutions to reduce food waste by reusing by-products and waste and recycling nutrients to develop a sustainable food SC (Pearce et al., 2018). However, integrating CE principles can be complex for individual firms independently, leading them to seek collaborations to facilitate the development of circular practices (Sehnem et al., 2019). Research indicates a positive correlation between the level of collaboration among companies and the number of CE objectives pursued (Elia et al., 2020). The systemic approach of CE requires reconfigurations at the SC level (De Angelis et al., 2018; Farooque et al., 2019), emphasizing the essential role of collaborating with external actors in developing functioning CE systems (Arias Bustos and Moors, 2018; Khan et al., 2020).

Although SC collaborations in the context of CE for FW prevention and management have been explored in the literature and their benefits for all parties involved have been proved (e.g., Niesten et al. (2017)),

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practical challenges in establishing and maintaining collaborative relationships with SC partners to tackle FW persist. To gain deeper insights into the mechanisms leading to the establishment of collaborations in a CE context for FW prevention and management, a novel perspective is needed.

While the literature has traditionally focused on collaboration as an enabler of CE practices moving from the premise of already established collaborations within the SC, we aim to investigate, instead, how the CE transition can influence the development of effective collaborations. In doing this, we focus on food manufacturers, given their critical role in driving CE practices to prevent and manage FW through their manufacturing processes and relationships with upstream and downstream SC partners.

Therefore, the research objective is to *explore how the transition towards CE can affect and shape the creation of collaborations for FW prevention and management, by examining the perspective of food manufacturers.*

In specifying the aim of this work, it is relevant to address the terminology used when referring to FW. Various terms describe food flows leaving the SC, and no consensus has been reached in the literature on a univocal definition (Chaboud, 2017). To avoid confusion, the term "*food waste - FW"* will be used throughout this work as encompassing and generally describing food flows leaving the SC. Further details on the nature of these flows will be provided as necessary.

Following the stated objective, we aim to provide an answer to the following Research Question (RQ): RQ1: "*How does the CE transition foster food manufacturers to engage in collaborations for FW prevention and management?"*

To address this RQ, we examine polar cases, specifically considering the firm's size, of companies adopting CE practices to compare and contrast opposite situations where the same phenomenon occurs. CE implies a paradigm shift in the conceptualization of industrial systems (Korhonen et al., 2018), and its broad scope can pose difficulties in its adoption, which company-specific features, such as size, may affect (Ghisellini and Ulgiati, 2020).

We perform this analysis in a specific sector relevant to the FW phenomenon to maintain a homogeneous context and control other variables. Specifically, the study focuses on two in-depth case studies of firms operating in the Italian fish manufacturing sector, selected through purposive sampling and representing polar cases: a small enterprise and the sector's leading company (a large company). The analysis of firms of different sizes allows isolating those elements that can be reconducted to the company's size. Moreover, including a small company enables exploration of CE implementation in food SMEs,[1] an underexplored topic in the literature (Ormazabal et al., 2018; Dey et al., 2020; Adams et al., 2021).

The findings are analyzed through the lens of Resource Dependence Theory (RDT). This theory has seldom been applied to CE (e.g., Gebhardt et al. (2022); Nag et al. (2021)) but is well established in the field of SC management to describe firms' responses to external resource dependencies (Bode et al., 2011; Drees and Heugens, 2013; Prajogo et al., 2020).

The approach adopted in this work tackles multiple research gaps and provides several contributions. The application of RDT offers a deeper understanding of how companies interact across the SC to develop CE collaborations and enables theory development for CE, which is scarce in literature so far. Drawing on RDT, the findings discuss the influence of mutual dependencies and power imbalances in establishing collaborations for FW prevention and management. This in-depth analysis of collaborations also provides empirical evidence of their deployment for FW prevention and management while demonstrating how CE can drive the establishment of such relationships, which constitutes a novel perspective in the literature. Investigating collaborative arrangements for FW minimization also exemplifies the strategic motivators and drivers that push firms to implement CE practices, representing a significant contribution provided by this work. Additionally, by taking the perspective of CE adoption driving companies to establish collaborations along the supply chain, this work sheds light on the mechanisms behind the establishment of collaborative relationships, extending beyond the traditional view of barriers and enablers of SC collaboration. This novel perspective, in fact, explained through the constructs of RDT, allows unveiling those strategies that, in the context of CE within the food sector, drive collaboration in the fish supply chain.

Moreover, including a small company in the analyzed sample enables a multifaceted description of collaborations, offering empirical evidence on how CE is adopted and managed in SMEs. The investigation of CE for FW prevention and recovery in a small food manufacturing firm allows an understanding of the perception of CE in SMEs and the motivations, drivers, and limitations experienced by small firms. This can help foster the broader diffusion of CE practices also in SMEs, which are the backbone of the economy of many countries across the world.

The remainder of this paper is organised as follows: Section 2 discusses the theoretical underpinnings of the study; Section 3 details the case study methodology employed to gather empirical data, presented in Section 4. Section 5 discusses the findings in light of RDT, and conclusions are drawn in section 6, highlighting contributions, limitations, and further research directions.

2. Theoretical background

2.1. Circular economy and food waste prevention and recovery

The Ellen MacArthur Foundation has defined CE as "*an industrial system that is restorative and regenerative by intention and design*" (Ellen MacArthur Foundation, 2012). CE conceptualizes waste as a resource (Ellen MacArthur Foundation, 2012), and both scholars and practitioners have recognized the potential of applying CE principles to FW (Ellen MacArthur Foundation, 2013; Halloran et al., 2014). Preventing or recovering food from waste through CE can significantly contribute to sustainable development. Annually, global food wastage is estimated at 1.3 billion tons (FAO, 2019), accounting for 8% of global greenhouse gas emissions (Vilariño et al., 2017). Considering these figures, the deployment of CE actions to address FW flows can be clearly linked to environmental sustainability goals. Wasting food also entails wasting all the resources used in its production, including economic ones. The value of wasted food on a global scale is estimated at around USD 1000 billion, remarking the relevance of adopting CE practices for its prevention or recovery (FAO, 2014). The social dimension of sustainability is much less discussed in CE literature (Sehnem et al., 2019). When considering FW, the link between social sustainability and CE is more evident since a diminished availability of food due to wastage can compromise food security (FAO, 2019). Several authors have highlighted how applying CE principles throughout the SC can enhance food security (Zhang et al., 2022).

When discussing CE's role in mitigating FW, the reference framework is the food waste hierarchy (FWH), first introduced by Papargyropoulou et al. (2014) and recently updated by Teigiserova et al. (2020). The FWH ranks the most preferable strategies for preventing and managing FW. The top priority is FW prevention, which can be achieved, for example, through process improvement and optimization or with the introduction of novel technologies (Mourad, 2016; Moraes et al., 2021). If FW is generated, it should be reused for human consumption (usually through donations to charitable organizations (Mourad, 2016; Priefer et al., 2016)) or for animal feed (in compliance with health and safety regulations (Teigiserova et al., 2020; Rajeh et al., 2021)). Below these options, the framework suggests recycling FW into products with

[1] SMEs are defined as "enterprises which employ fewer than 250 persons and which have an annual turnover not exceeding EUR 50 million" (European Commision, 2003).

significant market value and keeping the value of the food bound to the material (e.g., food products, biopolymers) (Teigiserova et al., 2020). Nutrient extraction is placed below material recycling as it involves the complete degradation of FW through processes such as composting and anaerobic digestion (Teigiserova et al., 2020; Assis and Gonçalves, 2022). Energy recovery, through anaerobic digestion or incineration, is placed as the second lowest tier in the hierarchy, just above disposal in landfills, which should be avoided (Teigiserova et al., 2020). Following the practices outlined in the FWH can help organizations reduce the generation of FW (Papargyropoulou et al., 2014; Somlai, 2022). However, implementing these CE strategies is more complex in developing countries, where FW is primarily sent to landfills (Thi et al., 2015). In these contexts, the lack of innovation, technology, and financial resources can strongly hinder the prevention and recovery of FW (Gedam et al., 2021).

Considering the skills, resources, and technologies required to implement CE (Bressanelli, Perona and Saccani, 2019; Tura et al., 2019; Ada et al., 2021; Mehmood et al., 2021), companies are required to make a strong commitment to drive the implementation of circular FW management practices (Tura et al., 2019; Yadav et al., 2020). This business orientation can be challenging for SMEs (Ormazabal et al., 2018; Adams et al., 2021; Rajic et al., 2022), which are not simply smaller versions of larger companies (Welsh, 1981). SMEs have peculiar characteristics that can impede the development of CE practices (Dey et al., 2020; Holzer et al., 2021). They often face limited resources to dedicate to sustainability projects, restricted financial capabilities, weak external support, and a lack of education and information (Nikolaou et al., 2016; Ormazabal et al., 2018; Sharma et al., 2021), as they are only small actors in wider value chains (Rizos et al., 2016).

2.2. Supply chain collaboration and its relevance to food waste prevention and recovery

CE adopts a holistic approach, meaning it aims at changing the entire economic paradigm (Ellen MacArthur Foundation, 2012): such extensive changes require the engagement of organizations with a broader audience to mainstream CE and achieve a systemic transformation (Farooque et al., 2019; Hussain and Malik, 2020; Bimpizas-Pinis et al., 2022). Developing partnerships for implementing CE practices provides companies with access to waste prevention and management solutions that individual actors may not be able to develop on their own (Arias Bustos and Moors, 2018; Batista et al., 2018; Despoudi et al., 2018). These collaborations enable companies to acquire new skills, knowledge, and technologies required for the development of CE (De Angelis, Howard and Miemczyk, 2018; Farooque et al., 2019; Köhler et al., 2022). Collaborations can occur within an organization or externally, through both vertical and horizontal collaborations (with SC partners or external parties) (Sudusinghe and Seuring, 2022). Independently from the type of collaboration, several authors have recognized the pivotal role of establishing joint CE solutions to recover value from waste (e.g. (De Angelis et al., 2018; Köhler et al., 2022; J. L. Mishra et al., 2019),).

In the context of FW, the effective implementation of prevention and recovery solutions often relies on the development of collaborations (Bloise, 2020; Matzembacher et al., 2021). A very common practice adopted along the food SC to prevent wastage is donating food products for human consumption. The movement of products to the recipients is usually mediated by a food bank. The collaboration with a food bank is a facilitator for CE, since food banks often have stable contacts with the recipients. Therefore, the possibility of reaching people in need to redistribute food and avoid FW is granted by the collaboration with the food bank (Garrone et al., 2014; Redlingshöfer et al., 2017). Collaboration not only reduces waste but also improves product quality, as results from the analysis of the collaborative relationships between agricultural producers and cooperatives by Despoudi et al. (2018). The close collaboration between farmers and cooperatives allows for aligning goals and objectives, sharing knowledge, information, and resources, fostering the minimization of agricultural waste and the enhancement of products' quality. (Despoudi et al., 2018; Bloise, 2020). The importance of information and knowledge sharing has also been underlined by Ciccullo et al. (2021), who studied the collaborative relationship between food companies and technology providers to reduce FW. This collaboration enables food organizations to gain access to additional competencies for CE. Thanks to the collaboration, food companies can introduce in the operations technologies aimed at improving monitoring and forecasting and enhancing food preservation, reaching the aim of preventing FW. At the same time, the technology providers can tailor their services to the food SC thanks to the companies' knowledge (Ciccullo et al., 2021). This case well exemplifies how collaboration fosters FW reduction thanks to the additional technologies and competencies it is possible to access. Another element that facilitates CE for FW is geographical proximity, which is found to enable the exchange of waste flows (Chertow, 2000; Bloise, 2020). This aspect can give rise to industrial symbiosis relationships, where companies optimize the material life cycle thanks to the exchanges established with surrounding industrial systems (Graedel and Allenby, 1995). The exchange of flows is enabled by close collaboration with industrial partners, which ensures the continuous and stable exchange of energy and materials flows to be reused or recovered. Regarding FW, this paradigm is, for example, applied to mushroom production, with the recovery of spent mushroom compost and mushroom leftovers as feedstock or fertilizers, in collaboration with local farmers (Patricio et al., 2018). Similarly, in the beer industry, spent grains and yeast can be destined for animal feeding thanks to the collaboration with breeders (Patricio et al., 2018). The described recovery solutions would not be possible without the establishment of collaborations since the type of recovery is not part of the core business of firms. Filimonau and Ermolaev (2022) proposed and explored the feasibility of an industrial symbiosis system based on the exchange of FW flows between restaurants and farmers. In this collaborative arrangement, FW generated in restaurants can be valorized as feed or fertilizers in farms; in turn, farmers can supply fresh produce to restaurants. These circular exchanges are enabled by the close collaboration between farmers and restaurants involved in the industrial symbiosis project. Food service providers and farmers demonstrated positive attitudes; however, this study underlined the need for policy support in the development of the system (Filimonau and Ermolaev, 2022). Beyond industrial symbiosis, the involvement of institutional stakeholders besides food companies can benefit the definition of actions for FW prevention and recovery. Collaboration between institutional stakeholders and private companies can help define an agenda for reducing FW within a given SC. Private companies are then responsible for promoting such strategies by engaging companies along the SC, thus establishing a dialogue also with these actors (Matzembacher et al., 2021).

2.3. Literature gaps

The presented theoretical background discusses the importance of developing CE actions to prevent and recover FW flows. CE efforts can help alleviate the sustainability impacts of FW generation; however, implementing CE practices may be challenging for SMEs. These difficulties are of great concern when considering that SMEs are the predominant economic actor in several economies: for instance, in Italy, SMEs constitute 99,9% of all enterprises (European Commission, 2022a). The prevalence of SMEs has consequences on the related greenhouse gas emissions, as it has been estimated that SMEs contribute to 63,3% of all emissions from European enterprises (European Commission, 2022b). Despite the economic and environmental relevance of SMEs, little research efforts have been devoted to understanding how CE is implemented in these organizations, especially in the food sector (Ormazabal et al., 2018; Dey et al., 2020; Adams et al., 2021). Since SMEs are not only smaller versions of larger firms, comparing their behavior towards CE to that of bigger companies is relevant to underline

effective approaches to reduce FW, which may be applied across enterprises of different sizes. Therefore, this study will provide evidence to fill this gap by examining the implementation of CE practices for FW in companies of different sizes operating in the same industrial sector, especially by comparing a small enterprise to a large corporation (market leader) through a polar case analysis.

This gap is complemented by a further literature shortcoming, which relates to the study of collaborations in the context of CE. The provided overview of collaborations for FW valorization exemplifies their relevance in achieving circularity and pinpoints them as an emerging topic in literature. Despite the growing attention to this subject, empirical studies on how collaborations are established and the mechanisms governing such arrangements are still limited in literature and require further investigation (Batista et al., 2018; Kirchherr et al., 2018; Mishra et al., 2022). This study will address this research gap by providing explorative empirical evidence on collaborations in FW recovery and prevention, taking the novel perspective of CE adoption leading to the establishment of collaborations along the supply chain.

Altogether, exploring the highlighted gaps is expected to contribute to achieving the objective of this work of understanding how the CE transition fosters small and large food manufacturers to engage in collaborations for FW prevention and management.

2.4. A Resource Dependence Theory perspective on circular economy for food waste prevention and recovery

The adoption and diffusion of CE practices have been studied through various theoretical lenses, such as transaction cost economics (Dossa et al., 2020), resource-based view (Jakhar, 2018), and institutional theory (Do et al., 2022). Recently, some authors have applied RDT to analyze dynamics arising when implementing circular practices, testifying increasing attention to applying this theory in CE. Cricelli et al. (2021) examined how collaborations can influence reverse logistics innovation using RDT. RDT has been employed by Nag et al. (2021) to study collaborations for circularity in terms of exchanged resources. The work by Gebhardt et al. (2022) takes a broader perspective on CE: it investigates to what extent CE practices can reduce SC dependencies, and it uses RDT to provide an overview of the dependencies related to each circular solution.

RDT focuses on the relationship between organizations and the external environment; the main constructs of this theoretical lens of relevance to this study are summarized in Table 1, together with their conceptualization in the context of this work. This theory investigates how external constraints influence firms and how firms respond to these constraints (Bode et al., 2011; Biermann and Harsch, 2017). External influences push companies to seek resources (tangible or intangible) in their environment, creating dependencies on these resources (Drees and Heugens, 2013; Biermann and Harsch, 2017). Resource dependencies imply a dependence on the firm holding the resources, so organizations can employ several strategies to mitigate the magnitude of these dependencies (Drees and Heugens, 2013; Manhart, Summers and Blackhurst, 2020). The scope of RDT makes this theory appropriate to investigate CE, whose implementation can result in the modification of supply networks and the dependencies among actors (Ellen MacArthur Foundation, 2012; De Angelis et al., 2018; Gebhardt et al., 2022). The following paragraphs present how RDT can be conceptualized in CE.

Companies are exposed to external pressures to implement sustainability in their operations (Pfeffer and Salancik, 1978a; Biermann and Harsch, 2017). According to RDT, companies exposed to the same constraints are expected to behave similarly (Pfeffer and Salancik, 1978a), with differences that can arise from the domain of operations (*i.e.*, sector of specialization) (Levine and White, 1961; Thompson, 1967). Cowan (1986) argues that companies also need a "motivation to act" to respond to external events, meaning an organization must be aware of an event and deem it important for its goals to develop a response. Hence, companies exposed to the same environmental constraints and operating in the same domain may not react analogously.

When companies decide to address sustainability and CE constraints, modifications in resource dependencies can occur since there are new resource requirements, with a consequent change in SC relationships and interdependencies (De Angelis et al., 2018; Gebhardt et al., 2022). In the case of CE for FW, food manufacturing companies produce waste;

Table 1
Summary of key constructs of RDT and their conceptualization in the context of this work.

Construct	Definition	Conceptualization
External constraints	Influence firms and push them to seek resources in their environment to respond to the constraints (Pfeffer and Salancik, 1978a; Drees and Heugens, 2013).	Pressure exerted on firms to improve their sustainability and CE behavior
Dependencies	Developed between the firm and the providers of the resources sought in the environment due to external constraints. Can have varying strengths and be reciprocal (Pfeffer and Salancik, 1978a; Drees and Heugens, 2013).	Need of capabilities, skills, and expertise required to prevent and recover FW flows
Motivation to act	Brings firms to react to external constraints; it is developed if the firm is aware of a specific constraint and deems it as relevant to its goals (Cowan, 1986).	Embeddedness of sustainability and CE concerns in the firm culture
Buffering strategies	Actions performed by the firm to mitigate dependencies by isolating the firm from the environment (e.g., safety stocks, flexible production process …) (Meznar and Nigh, 1995; Bode et al., 2011; Leonardi, 2013).	FW prevention and recovery practices implemented by the firm on its own
Bridging strategies	Actions performed by the firm to mitigate dependencies by creating links with the environment (partnerships, joint activities …) (Meznar and Nigh, 1995; Leonardi, 2013; Kalaitzi et al., 2018).	FW prevention and recovery practices implemented by the firm in collaboration with external actors
Power imbalance	In a dyadic relationship, power imbalance can be defined as the ratio of the power held by the most powerful firm with respect to the power of the least powerful firm (Lawler and Yoon, 1996; Casciaro and Piskorski, 2005)	Difference in bargaining positions between the firm and the external actor (referring to the linear supply chain)
Mutual dependence	In a relationship between two firms, mutual dependence describes if the existing dependencies are bilateral (Bacharach and Lawler, 1981; Casciaro and Piskorski, 2005)	Mutual interest of the firm and the external actor in engaging in activities for FW prevention and recovery
Countervailing resources	In a relationship between two organizations, countervailing resources are the resources offered by the partner firm in return and can justify the autonomy loss of establishing the collaboration (Oliver, 1991; Pfeffer and Salancik, 1978b).	Benefits obtained by the firms and the external actor thanks to the establishment of activities for FW prevention and recovery

thus, they face new dependencies on firms valorizing their waste (De Angelis, Howard and Miemczyk, 2018): symbiotic relationships need to be established, where the output of one organization becomes the input to another (Pfeffer and Salancik, 1978a; Drees and Heugens, 2013). The critical resources companies depend on when engaging in CE are the capabilities, skills, and expertise needed to recover waste flows (e.g., reverse logistics, recycling technologies, and remanufacturing capabilities) (Nag et al., 2021).

To handle the complexity of these novel dependencies, firms can use buffering or bridging strategies or a combination of the two (Kalaitzi et al., 2018; Manhart et al., 2020). Buffering strategies do not require interaction with external parties and aim at mitigating dependencies by isolating the firm from the environment (Meznar and Nigh, 1995; Leonardi, 2013). Bridging strategies have an external focus and aim at creating bridges with other firms (Meznar and Nigh, 1995; Leonardi, 2013; Kalaitzi et al., 2018). Bridging strategies entail the development of close relationships involving, for example, information exchange, joint activities, and cooperation, which include partnerships and vertical integration (Bode et al., 2011; Kalaitzi et al., 2018). From these examples, it is clear that both parties must agree to engage in such initiatives. The core elements determining the feasibility of establishing bridging strategies are the power imbalance and the mutual dependence between firms (Casciaro and Piskorski, 2005). Power imbalance refers to the different levels of power one actor holds over another (Lawler and Yoon, 1996; Casciaro and Piskorski, 2005). Power is very relevant in food SCs, characterized by asymmetrical power distributions that usually favor retailers and penalize SMEs (Dobson and Clarke, 2001; Hingley, 2005). Instead, mutual dependence can capture whether dependencies are bilateral or not, hence the extent to which the dependence of actor A upon actor B corresponds to the dependence of B upon A (Bacharach and Lawler, 1981; Casciaro and Piskorski, 2005). It has been shown that low power imbalance and high mutual dependence favor the creation of bridging strategies (Casciaro and Piskorski, 2005; Crook and Combs, 2007). When conditions are favorable for deploying bridging strategies, firms decide to embrace dependencies. This is always associated with an autonomy loss, which is acceptable if the partner firm can offer attractive resources in return (*i.e.*, countervailing resources) (Pfeffer and Salancik, 1978b; Oliver, 1991). A crucial resource exchanged through cooperation is legitimacy, which allows the company to be perceived as compliant with social guidelines (Suchman, 1995). In an environment that pushes organizations towards sustainability, sustainability legitimacy allows companies to market themselves as sustainable.

RDT can offer interesting perspectives on SC mechanisms when firms adopt CE practices. Few literature contributions have used RDT in the field of CE, and this work will contribute to this emerging topic, responding to Gebhardt et al. (2022) call to explore dependencies in circular SCs. Moreover, the food sector is characterized by power imbalances among SC actors, enabling the analysis of power relationships in the circular SC. The involvement of a small enterprise enables isolating this element more clearly and strengthens the motivation to adopt RDT to study this phenomenon.

3. Methodology

The literature review underlined the lack of knowledge on the theme of collaborations in CE, indicating that an exploratory case study is an appropriate method for this study (Eisenhardt, 1989; Yin, 2018). The case study methodology allows for the investigation of emergent phenomena occurring in complex environments by providing a thick description that may be difficult to achieve with quantitative methods (Barratt et al., 2011; Yin, 2018). Considering the investigated phenomenon, two polar cases are selected to identify the contrast between different situations (Yin, 2018) - in this case relating to firm size. Studying multiple case studies allows for comparing findings and detecting recurring phenomena (Eisenhardt, 1989); this perspective can be enriched by analyzing contrasting cases, where the different elements can be isolated, and the details of interest become observable (Pettigrew, 1995).

3.1. Case selection

The cases have been selected through purposive sampling (Eisenhardt, 1989) by adopting an intensity sampling strategy (Patton, 2002). Purposive sampling allows for the selection of cases, providing rich examples of the relevant phenomenon (Patton, 2002; Yin, 2018). The following selection criteria were adopted to study cases that intensely represent the area of interest.

a) Industrial Sector: firms operating in the Italian fish processing sector to ensure similar operations and contextual environment.
b) CE practices: companies with active CE practices for FW to ensure case relevance.
c) Size: companies of different dimensions to involve polar cases.

The list of companies satisfying the first criterion has been derived from The ORBIS database, which contains business information derived from more than 160 regulatory sources and information providers. This database is developed by Bureau Van Dijk, a publisher of business information that offers many repositories with different geographical scopes. The list of companies registered in the "Processing and conservation of fish, crustaceans, and mollusks" sector in Italy (criterion a) was extracted to control the size of the companies (criterion c); information on CE practices was obtained from company reports and websites (criterion b). Regarding the large enterprise, the market leader (Case A) satisfied all criteria and could provide a drastically different perspective from a small firm. To involve a small enterprise, Case B was selected among those companies providing sufficient information to ascertain their compliance with the study requirements and selection criteria. A brief description of the firms involved in the study is provided in Table 2.

3.2. Data collection

The information for the study was collected via data triangulation from different sources: interviews, notes, company reports, and websites. The primary data was the execution of in-depth interviews, which allowed for gathering rich insights and provided different perspectives on the topic under study (Kvale, 1994). The interviews followed a semi-structured protocol with open-ended questions (protocol in the appendix): the set of questions guided the interview, but further questions were posed on relevant topics. This interview type allowed respondents to express their opinions and freely discuss the investigated topic (Baxter and Jack, 2008; Yin, 2018). The flexibility of this methodology ensures analogous reporting on the principal themes while

Table 2
Cases description.

	Case A – Large company	Case B – Small company
Turnover (2022)	~270 million €	~4,5 million €
Employees (2022)	~350	~30
Location	Northern Italy	Northern Italy
Activities	100 fish species are sourced worldwide, distributed as fresh fish and live crustaceans, frozen fishery products, and ready-to meals. The company manages its logistics network, distributing its products to retailers, wholesalers, restaurants, and to its corner shops in malls.	Trout and other fish species are manufactured into ready-to products. Trouts are sourced from proprietary earthen ponds or other local aquacultures; other suppliers are employed to source other fish species. The products are distributed to retailers, wholesalers, small shops, restaurants, and through a shop on the plant site.

exploiting the specificity of the context by following the interviewees' leads and adapting the questions accordingly (Corbin and Strauss, 2014). Before each interview, data and details on the company were gathered through websites to better understand the information provided during the interview.

Two interviews were conducted with each informant, each lasting an average of 60 min; at least two researchers participated in the interviews. For Case A, the chief of quality and an officer of the health, safety, and environmental department took part in the study; for Case B, the general manager and the company president were interviewed. A follow-up meeting with the respondents was arranged to validate the interview transcripts and key findings, ensuring that no misinterpretations occurred.

3.3. Data analysis and validation

The conducted interviews were transcribed, and the gathered information was triangulated with notes and company reports. The involvement of the Italian association of companies operating in the sector of fishery products has provided a further source of triangulation: the general information provided by the association on the state of CE in this industrial sector provided a basis for comparison to strengthen the results (Yin, 2018).

The gathered materials and interview transcripts were analyzed using open coding techniques, where each line or paragraph was associated with a coding label representing the concept expressed in the data. These first-order labels were then categorized into higher-order themes representing the main topics discussed during the interviews: vision on sustainability and CE, prevention and management of FW, and prevention and management of FW through collaborations.

The quality of the research was evaluated by following the criteria and practices recommended in established literature. Credibility was achieved thanks to the triangulation of data types to ensure coherence. Moreover, the authors thoroughly discussed the results emerging from the data analysis. The open discussion of the results also ensured the embedding of the principles of RDT in the findings, creating a coherent dialogue with existing literature and further enhancing credibility (Lincoln and Guba, 1985; Miles and Huberman, 1994). Despite the limited generalizability inherent in the chosen methodology, transferability was assured through a detailed description of the area under investigation and a transparent reporting of the selected cases. The constructs of RDT were explicitly linked to the evidence arising from the cases to enable further adoption of this perspective and foster transferability (Riege, 2003). This last aspect also helped achieve dependability, as it provided evidence of the rigor of the study. Dependability was further ensured by clearly defining sampling criteria and using the same interview protocol across cases after its validation within the research team. The gathered data was jointly analyzed through formalized codes (Lincoln and Guba, 1985; Riege, 2003). Lastly, confirmability was mainly ensured through meticulous management of data regarding the cases, with accurate records of the methodological procedure. The care adopted in the study also justified the methodological and theoretical decisions reported here (Lincoln and Guba, 1985).

4. Findings

This section presents a within-case analysis of the data gathered for each case; Figs. 1 and 2 summarize the main findings: the sustainability perception within the company, the causes of FW, and the related management and prevention practices implemented within the company or in collaboration with other actors.

4.1. Case A

4.1.1. Sustainability orientation

Company A explained that sustainability is one of the pillars of the company's code of conduct, which shapes its strategy and fosters a culture of sustainability among its employees. The company holds the ISO 14001 certification related to environmental management, which supports the development of sound sustainability practices and helps minimize operations with a negative environmental impact.

4.1.2. FW causes

In the company's operations, the primary source of waste is the processing of fresh fish to produce ready-to foods: operations such as gutting and filleting generate 80% of the total FW. Another source of waste is related to inbound alive crustaceans, such as lobsters or spider crabs, since some specimens may arrive dead at the plant. Company A manages its logistics network and offers insights into FW during transportation: fish is a very fragile product, easily damaged during transport, potentially leading to the generation of FW. Along the SC, the company noticed that retailers often order quantities much higher than forecasted, potentially resulting in FW due to unsold products.

4.1.3. FW prevention

To prevent the generation of FW during processing, efforts are devoted to optimizing and improving production lines, with personnel dedicated to ensuring that machines do not remove valuable portions of the fish. This aspect is also crucial during the selection and testing of new machines, as the device is not selected if it removes an excessive portion of the fish.

FW prevention actions have also been introduced during distribution. The company's logistics division strives to make the distribution network as flexible as possible depending on the characteristics of each product. More fragile products are dispatched to closer locations, ensuring comparable quality upon arrival.

Prevention practices are also established with retailers. The firm

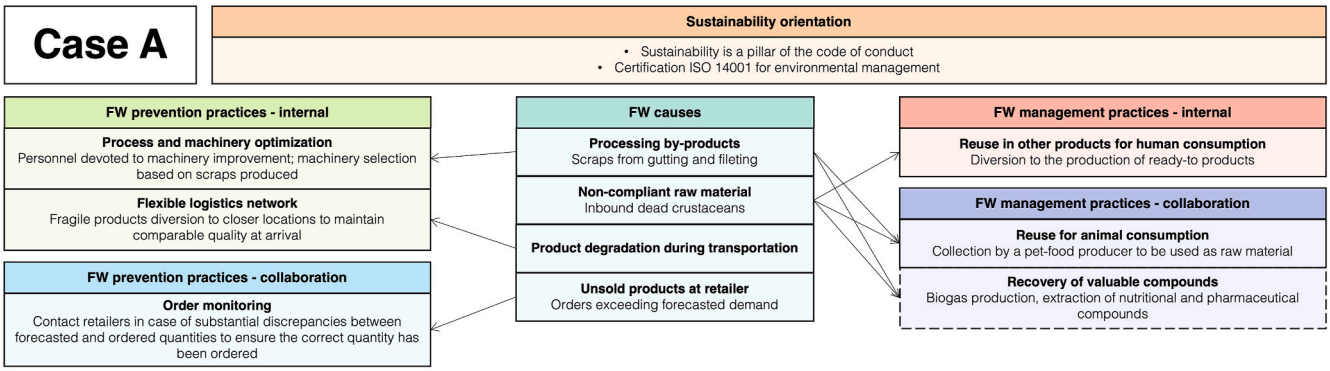

Fig. 1. Summary of the findings for case A; dotted lines represent practices considered but eventually not implemented.

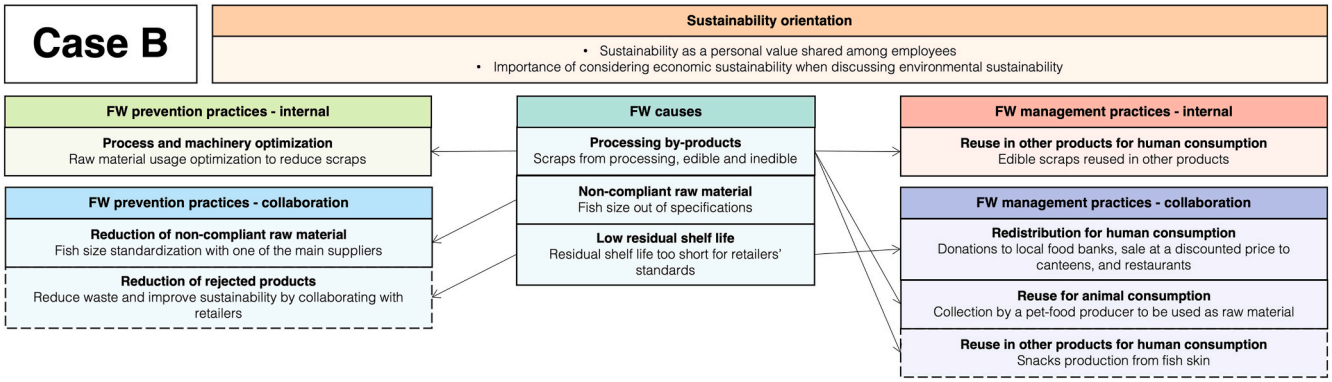

Fig. 2. Summary of the findings for case B; dotted lines represent practices considered but eventually not implemented.

forecasts the demand of its clients and then compares it with the ordered quantities: if a substantial discrepancy is noted between these values, the client is contacted and alerted, ensuring the correct quantity has been ordered.

4.1.4. FW management

Waste streams that cannot be avoided, such as dead crustaceans, require management: the quality of the inbound animals is immediately evaluated to certify their safety for use in producing ready-to products.

Processing by-products and crustaceans not certified as safe are stored in bins and destined for pet food production. The valorization of these materials into animal feed is made possible through a collaboration with a pet food producer. Given the significant quantities of fish waste produced each month (around 5–6 tons), the full bins are stored in a refrigerated container where the waste freezes; once full, the container is collected on-demand from Company A's site by the pet food producer. This collaboration has existed for several years, and the agreement between the companies has evolved. Company A used to receive a small economic compensation for the supplied waste, but in 2018, the pet food firm requested a contractual change and Company A now pays for the waste collection service.

The firm reported being interested in other FW management alternatives, such as biogas production or the extraction of nutritional and pharmaceutical compounds (e.g., omega-3, collagen) in collaboration with external actors. Contacts were established with firms offering such services, but factors such as geographical distance, high costs, and material availability hindered the development of these projects.

4.2. Case B

4.2.1. Sustainability orientation

In company B, a small family-run enterprise, sustainability is viewed as a personal value: the founding family has always been attentive to sustainability and has shared this core value with employees to create a harmonious company culture. While the company has not developed a formalized strategy that includes sustainability, the general manager stressed how this aspect has always guided the company's operations. The prevention and valorization of FW are considered to have both environmental and ethical implications, though the economic aspect of sustainability is also highlighted as very important.

4.2.2. FW causes

The firm exclusively produces ready-to products, and the most relevant source of waste is the transformation of fresh fish into finished products (e.g., fish bones, skins, heads, edible scraps …). The company identified a source of waste related to the raw material of one of its main suppliers: when trout are retrieved from the ponds, their dimensions might not meet company's B specifications. Fish from this supplier is employed in products requiring fish of specific sizes, so the non-compliant specimens become unsuitable for this purpose. Finished products may also be wasted as they approach the end of their shelf life since retailers require a minimum residual shelf life.

4.2.3. FW prevention

To prevent the generation of FW during processing, the company has optimized its processing operations to use a larger portion of the raw material, thereby reducing by-products.

Prevention strategies have also been reported in collaboration with external actors. Upstream in the SC, the company collaborates with one of its main trout suppliers to improve the quality of the supplied fish. This improvement process focuses on standardizing trout dimensions to address non-compliant raw materials. Company B worked with the supplier to optimize farming and ensure correct fish sizing in a project that required close cooperation between firms. The collaboration has been easy to develop since the firms had a long-term partnership, and both parties had a positive approach to the project.

Downstream in the SC, the firm tried to develop a collaboration with retailers on the themes of sustainability and FW, but retailers showed no interest despite their critical role in FW generation.

4.2.4. FW management

Some cutting operations in the trout fillet production line have been modified to improve the quality of the by-products. This line now produces smaller fillets, resulting in more fish being discarded, but these scraps are of higher quality: they can be used in other products, such as the trout tartare, providing more added value.

The company is in contact with local restaurants, canteens, and a food bank, who receive products that cannot be sold through retailers at a discounted price or as donations. Direct connections with representatives from these organizations make product redistribution for human consumption easy to arrange and manage.

The company has also developed a collaboration with a pet food producer to manage inedible waste flows deriving from processing. This waste is used as raw material in pet food products. The arrangement was defined to find the best solution for both parties: Company B places the by-products in designated bins that ensure proper material preservation, which are then collected on-demand by the pet food company. The company receives a small economic compensation for the provided material and perceives this arrangement as simplifying waste management.

The company has also been in contact with a start-up that uses fish skin to produce snacks for human consumption. However, the project's development faced many obstacles that eventually impeded the adoption of the CE practice: the logistical complexity due to geographical distance between the firms, the inability to supply the requested fish skin quantities, and the limited time and resources the company could allocate to the project.

5. Discussion

In this section, the evidence emerging from the cases is discussed in light of RDT, employing the constructs discussed in Table 1. The main outcomes of this analysis are summarized through propositions and are presented in Fig. 3, which underlines the differences arising due to firm size. Fig. 3 also exemplifies how the presented constructs of RDT are linked to the case findings and to the formulated propositions.

5.1. Implementing CE for food waste prevention and management

The selected cases allow the comparison of companies embedded in the same environment and domain: according to RDT, they are exposed to the same constraints and, hence, are expected to operate in similar ways (Levine and White, 1961; Pfeffer and Salancik, 1978b). This is confirmed as the companies experience similar FW causes, and both optimize their processes to reduce waste generation, use the scraps as input for other products, and collaborate with pet food producers to use fish waste as raw material. The similar response to CE requests highlights both companies have a "*motivation to act*", meaning they are aware of external constraints and react to them (Cowan, 1986); both firms perceive the external sustainability pressures as relevant to their company strategy and decide to take action (Cowan, 1986). The companies have followed different paths to embed sustainability in the company's culture. Company A has adequate resources to develop a strategy and a code of conduct, which is also required to ensure that all employees are aware of the mission and vision of the company to embed them in their daily operations. Moreover, Company A has invested in obtaining the ISO 14001 certification: "*The certification allows you to do something more, going beyond simply complying with regulations on waste.*". The small company, on the other hand, has fewer employees, making it easier to share sustainability values and a CE culture without developing formal documents. This concept was clearly described by the general manager of Company B: "*Sustainability is a personal value more than a company value: we are a small company, everything [of what is done] depends on personal values …*". These pieces of evidence highlight how the differing contextualization of sustainability and CE in the companies' strategies and culture can be attributed to their different size (Welsh, 1981).

P1a: Firms, regardless of size, have a "*motivation to act*" and develop solutions for FW prevention and management in response to increasingly urgent external pressures.

P1b: Firms' size influences the formalization of their sustainability culture and how the "motivation to act" to respond to sustainability constraints is embedded in the firm's culture.

5.2. Addressing new CE-related resource dependencies

The decision to address CE constraints alters the resource dependencies experienced by companies (De Angelis et al., 2018; Gebhardt et al., 2022), which, according to RDT, can be managed by adopting buffering or bridging strategies or a combination of the two (Kalaitzi et al., 2018; Manhart, Summers and Blackhurst, 2020). Both companies rely on buffering strategies, which RDT defines as those actions that mitigate dependencies by isolating the firm from the environment. These strategies include actions implemented solely by the company (Meznar and Nigh, 1995; Bode et al., 2011). An example is FW prevention, developed by both companies through process and machinery optimization: preventing waste generation implies the non-existence of flows to be recovered, minimizing the need to rely on external parties and thus mitigating dependencies (Carroll, 1993; Bode et al., 2011). Buffering strategies can also be applied to the SC (Kalaitzi et al., 2018; Manhart et al., 2020), as in the case of Company A, which established a flexible logistics network to dispatch more fragile products to closer locations to avoid FW generation. A further buffering strategy, alternative to waste prevention, is the internal use of edible by-products and waste flows, which both companies have implemented. These buffering strategies can only address a small portion of waste flows and entail minor adjustments in the companies' operations. These aspects can be linked to companies' capabilities: their core business is not waste valorization, so there are limited possibilities to extract value from by-products with in-house operations. Company B clearly explained: "*Sometimes finding solutions to valorize food waste becomes a burden, […also] because our core business is manufacturing, not value recovery from waste.*". This finding corroborates the considerations of Gebhardt et al. (2022) on the dependencies in materials recycling in a CE context: establishing internal recycling operations requires skills that most companies lack, pushing them to rely on external partners to achieve the desired goals. This reflection can also explain why buffering strategies primarily focus on preventing FW rather than its internal reuse. FW internal prevention or management is feasible as long as companies have the capabilities and resources to allocate to these efforts, usually more limited in small companies (Ormazabal et al., 2018). This finding is also

Construct	Conceptualization	Small firms	Large firms
External constraints	Pressure exerted on firms to improve their sustainability and CE behavior	*Perceived*	*Perceived*
Dependencies	Need of capabilities, skills, and expertise required to prevent and recover FW flows	*Fewer resources available internally*	*More resources available internally*
Motivation to act	Embeddedness of sustainability and CE concerns in the firm culture	*Present, embedded trough personal values*	*Present, embedded in a structured manner*
Buffering strategies	FW prevention and recovery practices implemented by the firm on its own	*Adopted for moderate FW streams*	*Adopted for moderate FW streams*
Bridging strategies	FW prevention and recovery practices implemented by the firm in collaboration with external actors	*Adopted for conspicuous FW stream and sooner than large firms*	*Adopted for conspicuous FW stream and later than small firms*
Power imbalance	Difference in bargaining positions between the firm and the external actor (referring to the linear supply chain)	*Low with suppliers, high with retailers*	*Low with retailers*
Mutual dependence	Mutual interest of the firm and the external actor in engaging in activities for FW prevention and recovery	*Present with suppliers, absent with retailers*	*Present with suppliers, present with retailers*
Countervailing resources	Benefits obtained by the firms and the external actor thanks to the establishment of activities for FW prevention and recovery	*Legitimacy, simplification, economic requirements, convenience, cost-effectiveness*	*Legitimacy, simplification, convenience, cost-effectiveness*

Propositions	
P1a	Firms, regardless of size, have a "motivation to act" and develop solutions for FW prevention and management in response to increasingly urgent external pressures
P1b	Firms' size influences the formalization of their sustainability culture and how the "motivation to act" to respond to sustainability constraints is embedded in the firm's culture
P2a	Firms, regardless of size, adopt buffering strategies when the FW streams are moderate, relying on their available internal capabilities and resources, while they resort to bridging strategies when the FW streams are conspicuous and their internal capabilities and resources are exhausted
P2b	The "tipping point" affecting the shift from buffering to bridging strategies depends on firms' size, with small companies resorting to bridging strategies sooner than large firms because their limited resources are exhausted at an earlier stage and consequently they are pushed towards collaborations and external dependences
P3a	Firms, regardless of size, consider legitimacy and simplification as key resources that determine the development of collaborations for FW prevention and management
P3b	Firms of small size consider economic requirements as further key aspects that determine the development of collaborations for FW prevention and management.
P3c	Firms, regardless of size, give priority to different CE practices based not only on recovered value as in the FWH but also on convenience and cost-effectiveness, which are affected by supply chain complexity.
P4a	Establishing collaborations for FW prevention and management in case of mutual dependencies and low power imbalances benefits the parties involved.
P4b	Establishing collaborations for FW prevention and management, in the case of unbalanced dependencies and high power imbalances, may be challenging (especially for small enterprises) when the countervailing resources and legitimacy perceived by both parties may not justify an increase in dependence, hindering the development of joint initiatives.

Fig. 3. Summary of the cases' analysis in light of RDT constructs.

in line with the paper by Young-Ybarra and Wiersema (1999), who explained that buffering strategies are more commonly employed at moderate levels of dependence, but when no alternatives are available, firms tend to form collaborations and alliances, thus resorting to bridging strategies (see Table 1). According to RDT, bridging strategies refer to actions aimed at mitigating dependencies by establishing links with the external environment (Meznar and Nigh, 1995; Leonardi, 2013). In the context of this study, when the waste flows are modest, companies find ways to develop internal CE solutions, such as the internal reuse of edible by-products, which only represent a small fraction of the overall waste (generally 50% of the weight of a fish consists of inedible parts (FAOSTAT, 2023)); the edible portion is exploited as much as possible by both companies. Both companies exploit their available internal resources to develop CE solutions until the required efforts exceed their capabilities. This occurs when the management and prevention practices are perceived as too distant from the core business. This "tipping point" appears to differ between the two cases, which can be explained by considering the firms' size. Small companies usually have fewer resources than larger firms (Ormazabal et al., 2018): bridging strategies are adopted sooner since available resources are more easily exhausted. Taking the perspective of the RDT, it is possible to state that the large company can allocate more resources to such activities, but once fully exploited, they can no longer use buffering strategies and must resort to bridging strategies. Through the same RDT perspective, both cases show that when the FW volumes increase, dependencies become more prominent, and firms tend to rely on bridging strategies, as further explained in the following sections. This shift from buffering to bridging strategies occurs at different moments across companies but aligns with the point at which internal capabilities and resources are exhausted. This occurs as companies do not perceive as feasible a substantial modification in their operations aimed at the recovery of more waste flows since other actors are available for this purpose.

P2a: Firms, regardless of size, adopt buffering strategies when the FW streams are moderate, relying on their available internal capabilities and resources, while they resort to bridging strategies when the FW streams are conspicuous and their internal capabilities and resources are exhausted.

P2b: The "tipping point" affecting the shift from buffering to bridging strategies depends on firms' size, with small companies resorting to bridging strategies sooner than large firms because their limited resources are exhausted at an earlier stage and consequently they are pushed towards collaborations and external dependencies.

5.3. Selecting collaborations as a mean to introduce CE

As detailed in the previous paragraph, the nature of CE pushes companies to engage in bridging strategies, which can help them gain sustainability legitimacy (Oliver, 1991; Suchman, 1995). Bridging strategies include all those actions that link the firm with the external environmental to mitigate dependencies (Meznar and Nigh, 1995; Leonardi, 2013). Both firms rely on bridging strategies, and in particular, an equivalent arrangement with pet food producers has been established by both companies. It emerged how this solution constitutes a great simplification for companies that are no longer in charge of waste management: "… *it is a service*" (A),"*… it's been very easy, we have economic savings, and logistically is much easier because they collect it*" (B). These findings underline simplification as an intangible resource exchanged in the relationship that drives companies to establish collaborations. Simplification appears to be a critical resource that companies depend on to implement circularity, evident when analyzing the case of the large company. Initially, the company received economic compensation for the scrap material provided to the supplier. Then, the pet food producer asked to change the contractual agreement to be paid for the service provided, and company A accepted this request. This decision can be explained through RDT: the company was highly dependent on the supplier because it allowed reaching sustainability goals (Emerson, 1962) and provided a significant simplification (Company A produces 5–6 tons of FW monthly). This strong dependence pushed the company to accept the new terms since the intrinsic intangible benefits outweighed the costs. The simplification aspect is also crucial for the small company, but ensuring economic sustainability is just as important: "*It is done because we can avoid wasting materials, but also because it has an economic value.*" and again, "*The economic aspect is crucial, not in the sense we must have a return from CE practices, but at least achieving economic sustainability is fundamental.*". The different approaches to the same FW management practice are explained when considering the different firms' sizes: SMEs have limited financial capabilities (Nikolaou et al., 2016; Ormazabal et al., 2018), often linked with a slower adoption rate of green innovations (Rizos et al., 2016). These findings are partially confirmed in this case since the same practice is implemented in both firms, but the smaller company has clearer and well-defined economic requirements that shape the partnership with the pet food producer.

The small company has active collaborations with food banks and local charities: these arrangements don't involve an economic return, but this recovery option is straightforward: *"It's very easy, we are organized and have direct contacts with people from the organizations we collaborate with, so it is very simple."*. Once again, the possibility of implementing CE activities is driven not only by the commitment of the company to prevent the generation of waste but also by the simplicity of implementation, emphasizing simplification as a significant resource exchanged in the relationship. The theme of simplification also clearly emerges when analyzing the CE projects the companies decided not to pursue. As explained by both companies: "Sometimes companies propose a very cool valorization of the waste, but creating the link with this company is unfeasible because they operate in Germany. How do you get there? We are talking about waste: we can't use our usual logistics network … Then we look at the waste, and you [the supplier] can only use certain fish species, and we can only offer 100 kg in three months, not enough to activate the process." (A), "We tried looking into it, but it was difficult to actually implement because it was complex for us and the supplier was not located near us." (B). All the projects (nutraceutical components extraction, biogas production, and snacks production) offered sustainability legitimacy (see Table 1) but required companies to segregate the waste, prepare it for treatment, and ship it to the supplier's plant, often situated in a distant location. In addition to these difficulties, the volumes of waste companies could make available to the new suppliers were small and insufficient to justify such efforts. These conditions were deemed too complex by the companies and led to the failure of the projects: simplification appears as a key resource that can determine the success or failure of CE projects, even when new bridging strategies could have provided more legitimacy in CE terms. These findings align with the study of Gebhardt et al. (2022), who employed RDT to explore CE and underlined how increased SC complexity could hamper the development of CE initiatives. The availability of alternative suppliers offering similar CE services (*i.e.*, pet food producers) makes the linked resources less critical and lowers the dependence of companies (Blau, 1964; Barney, 1991), hus making significant SC changes unjustifiable (Kalaitzi et al., 2018). This finding also highlights that companies have a distorted perception of the FWH (Teigiserova et al., 2020). The companies asserted being aware of this framework and recognizing certain circular practices as capable of extracting more value from waste, but their actions partially contradict these statements. When confronted with the complexity of CE, companies tend to choose the simplest arrangements, even if they do not align with the FWH. The importance of simplification and economic aspects reshape the structure of the FWH, depending on the most convenient and cost-effective solutions. These behaviors confirm what has been noted by Gebhardt et al. (2022) through the lens of RDT: the most relevant CE measures are not always at the top of the hierarchy, as this framework changes when SC complexity is considered. This can also be explained by considering the

companies' investment in CE goals, as when discussing RDT Emerson (1962) stated: "*The dependence of actor A upon actor B is proportional to A's motivational investment in goals for whose attainment A requires B's resources.*" Since other waste valorization actions are already in place, the firms' motivational investment is reduced, and thus, the related resource dependencies that could push them to engage in new CE projects. Waste volumes also influence dependencies: as stated above, scarce waste flows determine a lower level of dependence, and often, the volumes companies can make available to new suppliers are limited.

P3a: Firms, regardless of size, consider legitimacy and simplification as key resources that determine the development of collaborations for FW prevention and management.

P3b: Firms of small size consider economic requirements as further key aspects that determine the development of collaborations for FW prevention and management.

P3c: Firms, regardless of size, give priority to different CE practices based not only on recovered value as in the FWH but also on convenience and cost-effectiveness, which are affected by supply chain complexity.

5.4. Managing collaborations to benefit from CE

Established collaborations can offer insights on the benefits of engaging in bridging strategies to manage CE-related resource dependencies. Upstream in the chain, company B developed a collaboration with a supplier to reduce non-compliant raw materials. In this collaboration, both parties had comparable bargaining positions, and a balanced interdependence guided the project (Yuchtman and Seashore, 1967; Biermann and Harsch, 2017). As one representative noted: "*We have been collaborating with this company since the beginning because they are important suppliers for us, and we are important clients for them. The collaboration has been guided by the offered opportunities. There has been a good spirit to the partnership.*". This description of the relationship with the supplier highlights a mutual dependence, with both firms recognizing the benefits of closer collaboration. Moreover, the mutual importance hints at a low power imbalance between the parties, according to RDT. These factors facilitated the development of a collaboration aimed at FW reduction since there were no obstacles to its establishment (Casciaro and Piskorski, 2005). The project offered "*countervailing resources*" for both parties involved (as defined in RDT, countervailing resources are those resources offered by one firm that justify the loss of autonomy deriving from establishing the collaboration (Pfeffer and Salancik, 1978b)). Company B gained sustainability legitimacy and the possibility to receive better raw materials, hence reducing FW. The supplier gained sustainability legitimacy and the opportunity to offer better raw materials to all clients. This highlights that dependence in collaborations is to be accepted as given but can legitimize the parties involved (Pfeffer and Salancik, 1978b; Biermann and Harsch, 2017), creating reciprocity (Drees and Heugens, 2013). In accordance with RDT, similar arrangements can be obtained, as in this case, when the parties have a mutual dependence and comparable power, but their development can be impossible in the presence of unbalanced dependencies and power imbalances (see Table 1). This is exemplified by the small company's difficulties in engaging with retailers when they are not viewed as a significant supplier. Company B explained: "*These players have their own interests, and starting a collaboration with us, a small enterprise, that doesn't make the most of their volumes, is not worthwhile for them*". When offered the opportunity to develop initiatives to mitigate the generation of FW, potentially providing benefits for both parties, retailers appeared as not interested in the project: the legitimacy offered by company B was deemed as not sufficient to justify a dependence increase, as explained by RDT (Pfeffer and Salancik, 1978a; Oliver, 1991). In this case, mutual dependence is not found, and retailers can exert their stronger bargaining power to resist the bridging attempt of Company B (Casciaro and Piskorski, 2005). In contrast the large company, which has an influential bargaining position with big retailers, had an open dialogue with retailers on FW issues. As they noted: "*If we forecast that a certain retailer will order '100', but then they request '300', we understand it's a mistake, and we say 'Stop!', because too much food will be wasted.*". The company's network embeddedness influences the balance and level of resource dependencies (Benson, 1975; Cook, 1977; Pfeffer and Salancik, 1978a), and RDT discusses how the large size of the company allows for modification of the context of operations in significant ways (Pfeffer and Salancik, 1978a). The power imbalance is reduced due to the larger size of the firm, making retailers less resistant to collaboration (Casciaro and Piskorski, 2005).

Looking at all the described collaborations, it emerges how these arrangements can benefit all parties involved. In discussing RDT, Harsch (2015) argued that only material trades are always beneficial while exchanging intangible resources, such as legitimacy, can be a "zero-sum game" if one company is damaged by the collaboration with the other. This statement regarding RDT appears to not hold true in the context of CE for FW, where dependence on external organizations can lead to establishing symbiotic dependencies (in which the output of one organization is the input of the other (Pfeffer and Salancik, 1978a)) and reciprocity (Drees and Heugens, 2013). Developing such collaborations is not always straightforward: it requires the parties involved to have a proper "motivation to act" (Cowan, 1986), balanced power, to be able to address mutual dependencies (Casciaro and Piskorski, 2005), and to recognize the opportunities such dependencies can offer in terms of countervailing resources (Oliver, 1991; Pfeffer and Salancik, 1978b)).

P4a: Establishing collaborations for FW prevention and management in case of mutual dependencies and low power imbalances benefits the parties involved.

P4b: Establishing collaborations for FW prevention and management, in the case of unbalanced dependencies and high power imbalances, may be challenging (especially for small enterprises) when the countervailing resources and legitimacy perceived by both parties may not justify an increase in dependence, hindering the development of joint initiatives.

6. Conclusion

This manuscript has presented the cases of two manufacturing companies operating in the Italian fishery SC, offering exploratory evidence on how CE for FW prevention and management can foster the development of collaborations while also considering the role of firm size in these mechanisms. Employing the theoretical lens of RDT has enabled us to describe how companies of different sizes decide to engage in CE, select the most appropriate strategies, and manage collaborations to benefit from these arrangements.

Our evidence indicates that all companies share a motivation to act, driven by the importance of preventing and managing FW (Cowan, 1986). The transition to CE in this context leads organizations to establish collaborations, adopting practices and initiatives that extend beyond their company boundaries. This happens because CE requires resources and competencies that, when FW streams reach a certain threshold, may exceed internal resources. Given that SMEs usually have limited resources at their disposal, they tend to seek collaborations at an earlier stage compared to large organizations to face CE challenges (Ormazabal et al., 2018). The key elements driving successful collaborations in this sense are mainly represented by benefits such as legitimacy and simplification, which for SMEs are also subject to economic considerations (Pfeffer and Salancik, 1978a; Suchman, 1995). Due to the typical structure of the food supply chain, SMEs often reach out to large organizations (e.g., large retailers) when they strive to access resources not available internally to close the loop of waste flows (Hingley, 2005). This causes unbalanced dependencies and power asymmetries in the collaboration, which seem to hinder the success of the collaboration itself when the large counterpart in the relationship does not perceive intangible benefits beyond the recovered value of FW (Suchman, 1995; Casciaro and Piskorski, 2005).

6.1. Theoretical implications

From a theoretical standpoint, our work contributes to the literature on supply chain collaboration, by taking a novel perspective on the development of collaborations in the context of CE. In fact, instead of starting from established collaborations and exploring their deployment in the supply chain, we explore how the transition to CE affects the development of collaborations. The involvement of firms of different sizes offers the opportunity to contribute to the literature on how CE practices are adopted by SMEs and large firms (Ormazabal et al., 2018; Dey et al., 2020; Adams et al., 2021). The findings of our study confirm how economic sustainability is a strong driver for SMEs in the implementation of CE (Dey et al., 2020). However, the CE actions implemented are comparable those chosen by the large company (concerning quantity and type). This demonstrates how SMEs can see CE as a priority, even though its deployment is influenced by firm size (Rizos et al., 2016; Ormazabal et al., 2018). Through the lens of RDT, the findings contribute to discussing the influence of mutual dependencies and power imbalances in developing collaboration within the context of CE for FW prevention and management, arising from the paradigm shift embedded in the development of circularity practices. Our findings underline the critical role of these aspects in determining the establishment of collaborations, as discussed by Casciaro and Piskorski (2005). When the conditions are favorable, bridging strategies entail the exchange of sustainability legitimacy, benefiting both involved parties. This finding is specific to CE, as the exchange of intangible resources has been described as a "zero-sum game" in RDT literature (Harsch, 2015). Another significant theoretical contribution of this work is represented by the investigation of the applicability of established and widely accepted theoretical frameworks such as the FWH. Our work, in fact, shows that while the FWH still represents a foundation for the adoption of CE practices to prevent and manage FW, the proposed hierarchy does not drive the actions of companies in all contexts. The collected evidence, in fact, suggests that there might be other factors changing the priorities of organizations in undertaking initiatives not depending on the value of the recovered FW only, namely legitimacy, simplification, convenience, and cost-effectiveness. These considerations corroborate and better detail the findings of Gebhardt et al. (2022), who underlined how SC complexity can modify the structure of the FWH. Overall, the paper discusses the resources and benefits related to bridging strategies and the conditions that push companies to choose them over buffering strategies. This is a relevant contribution of this work, which enables identifying the strategic motivators that encourage companies to engage in collaborations for CE. Including a small firm and using RDT provide great detail on these aspects, which have been understudied in CE literature so far (Batista et al., 2018; Adams, Donovan and Topple, 2021).

6.2. Practical implications

Practical contributions complement these theoretical insights since the findings can provide firms with a better understanding of CE and of collaborations in this context. Despite the exploratory nature of this study, the application of RDT enables extrapolating the findings from the context of this study. The analysis of collaborations in the context of CE can help food manufacturing companies understand when and how these can be employed to prevent and recover FW. These results are particularly relevant for firms handling highly perishable products, whose management requirements are similar to those of fish. Moreover, the insights of our study can help consolidate CE actions in organizations that have several available alternatives for FW valorization and prevention, as in the discussed cases. The study highlights the importance for companies of developing collaborations adopting bridging strategies over buffering strategies to move towards a real transition to CE, whose requirements exhaust their internal resources. To realize this transition, companies need to look for intangible benefits beyond economic value, and legitimacy and simplification can be significant in the investigated context. Simplification has emerged as a key driver for companies since collaboration and the implementation of CE practices might appear too complicated to achieve and distant from their core business, and their motivation to act is not enough to justify such an effort. Hence, the key role of intermediaries or external companies emerges, which can liaise with food manufacturers to manage FW on their behalf and simplify this process, ensuring benefits for all parties involved. These intermediaries should be able to highlight the related intangible benefits for food manufacturers beyond the value of the recovered FW. These considerations underline the complexities embedded in the implementation of CE, stressing how the findings of our study can help organizations navigate these difficulties. The precise identification of strategic motivators and mechanisms involved in establishing collaborations for FW prevention and recovery represents a core practical contribution of this work. Providing clear guidance on collaborations for CE can involve more companies in the development of this economic paradigm. Achieving a CE requires reconceptualizing waste as a resource (Ellen MacArthur Foundation, 2012). The numerous examples of circular actions for FW prevention and recovery presented in this work can help mainstream this concept, thanks to a clear description of real CE arrangements. This can have implications at a broader scale since it can promote more sustainable production patterns that can ultimately reduce the negative impacts of FW and the excessive exploitation of natural resources.

6.3. Limitations and future research directions

Despite the declared intention of executing an exploratory study, the analysis of two companies operating in the same industrial sector restricts the generalizability of the findings and could result in a narrow view of the topic. The understanding of collaboration arrangements could be limited by the involvement of just one actor without including suppliers' perspectives. These limitations can guide further research directions that can contribute to expanding the knowledge on these topics. Future studies could focus on refining the understanding of the role of collaborations in CE and the role of company size in developing these partnerships. These studies could be conducted by focusing on other food products or on other industrial sectors to give more robustness to the findings. Future research should also include the perspective of external collaborating companies, especially to substantiate our findings regarding the benefits involved in CE collaborations.

Furthermore, our study does not address the broader consequences of establishing CE practices for FW valorization. The underlying assumption of this work is the ubiquitous positive impact of CE. This aspect requires closer consideration, as it emerges from our work that the economic sustainability of CE strategies is not always assured. This could be extended to other sustainability aspects, for example, by considering if the chosen FW prevention and recovery strategies are truly capable of reducing greenhouse gas emissions and displacing primary production. These concerns have been labeled as "circular economy rebound" (Zink and Geyer, 2017), and further studies should look at CE from a more critical perspective to assess all the implications, both positive and negative, of using this economic paradigm to prevent and recover FW.

CRediT authorship contribution statement

Stella Viscardi: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Conceptualization. **Claudia Colicchia:** Writing – review & editing, Methodology, Investigation, Conceptualization. **Alessandro Creazza:** Writing – review & editing, Methodology, Investigation, Conceptualization. **Quynh Do:** Writing – review & editing, Conceptualization. **Nishikant Mishra:** Supervision, Conceptualization.

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Declaration of competing interest

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

Appendix

Interview structure

- **Company profile**
  - Provide a description of the company and its history.
  - Provide a description of the upstream and downstream supply chain.
- **Perception and vision on sustainability and circular economy**
  - How relevant are the themes of sustainability and circular economy for the company?
  - How are sustainability and circular economy embedded in the company? (e.g., business strategy, initiatives …)
- **Food waste generation, management, and collaborations**
  - How and where is food waste generated along the supply chain?
  - Describe the initiatives in place to prevent or manage food waste, and specify potential collaborations needed for these practices. For practices that involve collaborations, describe the arrangement.
  - Describe other food waste prevention and management practices in which the company is/was interested. Specify if the practices would involve/involved collaborations and describe the arrangement.

Data availability

Data will be made available on request.

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