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Orchestrating cradle-to-cradle innovation across the value chain

Overcoming barriers through innovation communities, collaboration mechanisms, and intermediation

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Abstract

The circular economy (CE) aims at cycling products and materials in closed technical and biological loops. Cradle to cradle (C2C) operationalizes the CE with a product design concept rooted in the circulation of "healthy" materials because contamination of materials with substances of concern hampers cycling and may pose risks to people in contact with them. Extant research shows that barriers often hinder organizations from successfully pursuing cradle-to-cradle product innovation (CPI). Innovation community theory helps to explain how to overcome barriers and further the innovation process by taking a microlevel perspective on intra- and interorganizational collaboration of individual promotors (or champions). We elaborate innovation community theory with a longitudinal embedded case study of a C2C frontrunner company with the goal to get a precise understanding of how promotors collaborate in the CPI process. Our contribution is threefold: We identify eight collaboration mechanisms used between promotors to sequentially overcome a hub firm's individual, organizational, value chain, and institutional level barriers to circularity. Second, we differentiate these mechanisms according to their cooperative and coordinative facets and put emphasis on the coordinative functions of those mechanisms linked to the C2C standard. Third, we highlight the importance of promotors at the linking level who facilitate the CPI process as intermediaries.

KEYWORDS
circular economy, cradle-to-cradle product design, industrial ecology, innovation community, innovation intermediary, network orchestration process

1 | INTRODUCTION

The circular economy (CE) aims to be a restorative system (Morseletto, 2020) by keeping products, components, and materials in closed technical and biological loops at their highest utility and value (Bocken, Olivetti, Cullen, Potting, & Lifset, 2017; Ellen MacArthur Foundation, 2013). This requires radical innovation along the entire product lifecycle (Ghisellini, Cialani, & Ulgiati, 2016). Cradle to cradle (C2C) is a circular product design concept with attached certification system focusing on material circularity and health that has gained some attention in the market (Braungart, McDonough, & Bollinger, 2007). But the requirements for C2C product innovation (CPI), such as the elimination of toxic substances from the supply chain, cause considerable complexity and represent barriers for a large-scale diffusion. Extant research on CE barriers has identified these challenges, but often remains silent on their resolution (e.g., Kirchherr et al., 2018; Paletta, Leal Filho, Balogun, Foschi, & Bonoli, 2019).

It has become evident that collaboration in networks is at the core of product-level circularity (e.g., Hansen & Revellio, 2020; Konietzko, Bocken, & Hultink, 2020). As research in both product-level circularity and broader industrial ecology shows, such interorganizational collaboration requires careful network orchestration (Boons & Baas, 1997; Korhonen, Nuur, Feldmann, & Birkie, 2018) and facilitation (Paquin & Howard-Grenville, 2012; Patala, Salmi, & Bocken, 2020).

We are interested in the microfoundations of network orchestration to make "the problem-solvers visible" (Andrews, 2000, 37). This means, analyzing "the interactions of individuals, processes, and structures that contribute to the aggregation and emergence of collective constructs" (Felin, Foss, Heimeriks, & Madsen, 2012, 1353). Innovation community theory (Fichter, 2009) enables this perspective by explaining how individual promotors[1] collaborate across intra- and interorganizational boundaries, jointly overcome innovation barriers, and ultimately drive the innovation process across a network of firms. This theory was also recently adopted in industrial symbiosis research (Kokoulina, Ermolaeva, Patala, & Ritala, 2019). Still, the specific collaboration mechanisms used in such communities for resolving CPI barriers remain so far unexplored. This article tackles this void by questioning: *How do individual promotors from organizations across the value chain develop an innovation community, collaborate over time, and set aside barriers to CPI?*

We conduct a longitudinal embedded case study of the CE frontrunner firm Werner & Mertz (W&M) which has successfully developed C2C products. We contribute by providing a process perspective on the mechanisms of promotor collaboration showing how promotors configure them over time to resolve a hub firm's individual, organizational, value chain, and institutional barriers. We then differentiate cooperative and coordinative facets of these mechanisms (Gulati, Wohlgezogen, & Zhelyazkov, 2012) and emphasize the role of the C2C standard in coordination. We also highlight the role of an intermediary as important promotor in the innovation community.

2 | LITERATURE REVIEW

2.1 | Circular economy from a cradle-to-cradle perspective

As an umbrella concept, the CE borrows from C2C by differentiating between biological and technical loops (Blomsma & Brennan, 2017). Products with inherent dissipative losses (materials of consumption) should be designed to be biodegradable; other products (materials of service) should be designed for continuous and safe cycling without material downgrading (Braungart et al., 2007). Organizations can adopt the CE from two perspectives (Urbinati, Chiaroni, & Chiesa, 2017): *downstream* practices address the service offerings in the market for (longer) use and reuse of products. *Upstream* practices involve circular product design (den Hollander, Bakker, & Hultink, 2017) and related supply reconfigurations. Product redesign is important as perpetual cycling in biological and technical metabolisms is often hampered because products, components, and materials were not designed for a CE (Braungart et al., 2007). On the material level, the goal is to prevent *technical contamination* stemming from source material impurities or contaminants from related processes, as this leads to material downgrading in subsequent use cycles or harms people and the environment (Baxter, Aurisicchio, & Childs, 2017). Material toxicity should be identified and safe alternatives developed (Goldberg, 2017). The development and application of such high-quality *technical nutrients* becomes economically viable in a closed-loop scheme (Braungart et al., 2007).

2.2 | Cradle-to-cradle product design and certification

While CE research and practice frequently addresses product design, the particular aspect of preventing technical contamination is often neglected. It is the particular strength of the C2C design philosophy and practice to operationalize designing-out technical contamination. In contrast to the long tradition of *relative* eco-design approaches, C2C is considered a more *absolute* approach (den Hollander et al., 2017). While several specialized standards have emerged addressing aspects of the CE (e.g., Recycled Content Standard, SCS Global Services, 2014), C2C has been formalized into what can be considered the first comprehensive product certification standard. It currently covers approximately 391 certified products by 187 manufacturers worldwide (Ünal & Shao, 2019). How extensive it is implemented varies along motives (Smits, Drabe, & Herstatt, 2020) and a firm's ability to absorb external knowledge (Schmitt & Hansen, 2018). The C2C certified products standard (C2CPII, 2016) supports companies' innovation processes by breaking the overarching design philosophy down into specific criteria. We focus on product-level criteria: *Material reutilization* requires changes in product design and related processes for biological or technical cycling. *Material health* is about preventing technical

[1] The word "promotor" in this article follows the usage in related literature but its meaning matches the English word "promoter".

contamination by banning substances of concern (SoC) that are evaluated—based on the latest scientific evidence—as carcinogenic, mutagenic, or reprotoxic (CMR), persistent, bioaccumulative, and toxic (PBT), endocrine disrupting, or having respiratory, allergic, or immune effects (in particular, volatile organic compounds evaporating from products designed for indoor use). To this end, companies have to specify all material content above the 100-ppm threshold with reference to the Chemical Abstracts Service (CAS) number[2]. This C2C approach covers a much broader scope of SoC and represents a factor 10 increase of resolution as compared to the 1,000-ppm threshold for the rather narrow list of *Substances of Very High Concern* by the European REACH regulation on the Registration, Evaluation, Authorization and Restriction of Chemicals (European Commission, 2006, Annex II). The site-specific criteria *water stewardship*, *renewable energy and carbon management*, and *social fairness* assess the ecological and social performance of production facilities in relation to the product. The C2C standard also differs from other product certifications by its five performance levels (i.e., Basic, Bronze, Silver, Gold, and Platinum) for stimulating innovation and continuous improvement.

2.3 | Cradle-to-cradle product innovation and related barriers

In this article, we apply an innovation management perspective to C2C. CPI is part of the broader concept of sustainability-oriented innovation in which product, service, and business model development become an integral part of innovation management to improve the product lifecycle (Hansen, Grosse-Dunker, & Reichwald, 2009). We focus on the product (and associated materials) and related process innovations aimed at closing product lifecycles. Circularity has made innovation even more complex by calling for companies to radically rethink their products and consider loop closure already at the design stage (de Pauw, Karana, Kandachar, & Poppelaars, 2014; Go, Wahab, & Hishamuddin, 2015). Providing clear targets in early design phases supports the innovation process (de Marchi, 2012). As absolute product design approach, the C2C certification standard provides such targets by offering an ideal state. Disagreement exists about whether such checklists constrain creativity at the innovation front-end (de Koeijer, Wever, & Henseler, 2017) or further it (den de Pauw, 2015; Hollander et al., 2017).

In any case, there are considerable barriers to CPI that make many organizations fail. According to Guldmann and Huulgaard (2020), barriers to circularity are located on four levels (see Table 1 for details):

- Individual barriers relate to restricted mindsets resulting in a lack of commitment for promoting a CE (Kirchherr et al., 2018). The need for new competences (e.g., product designers) can lead to employee resistance to change (Sandberg & Aarikka-Stenroos, 2014).
- Firm-level barriers cover the difficulties to obtain project support (Guldmann, 2018). Business models and production technologies are often optimized for linear product concepts (de Jesus & Mendonça, 2018).
- Value chain barriers can relate to underdeveloped supply networks, with actors unwilling to provide or return suitable materials (Mont, Plepys, Whalen, & Nußholz, 2017) often because of (intellectual) property concerns (Preston, 2012). Product redesign may involve developing suppliers and other partners (Seuring & Müller, 2008), but time for interorganizational partnerships is often missing (Guldmann & Huulgaard, 2020). Customers may lack awareness (Mont et al., 2017).
- Institutional barriers include regulatory constraints, lack of governmental incentives, or low prices of primary raw materials (Kirchherr et al., 2018; Mont et al., 2017).

In general, overcoming barriers to CPI requires collaboration across multiple levels. Existing literature therefore highlights networks for CE implementation (Franco, 2017; Konietzko et al., 2020). Networks form around known partners and required technical capabilities and are governed by collaborative structures among co-specialized equals with fair value capture for all involved firms (Konietzko et al., 2020). Still, customer-supplier relationships and relative size and power of a hub firm determine suppliers' willingness to collaborate for CPI (Franco, 2017).

While collaboration in networks is central for CPI, its microfoundations covering the role of individuals, processes, and their interactions (Felin et al., 2012), remain mostly absent. We focus on innovation *communities* with informal links between individuals across organizations and differentiate it from the broader innovation *network* covering the organizations themselves. The community as a team then takes the role of an *aggregated orchestrator* of the innovation network (Klerkx & Aarts, 2013).

2.4 | Overcoming barriers with innovation communities

We are interested in the humanistic side of network development as represented by individual champions in building-up industrial symbiosis networks (Hewes & Lyons, 2008; Kokoulina et al., 2019) and the collaboration of individuals in learning action networks to advance corporate sustainability (Clarke & Roome, 1995; Clarke & Roome, 1999). Implicit in these early works is the importance of network embeddedness, that is, the strength of often informal relationships among members, their cognitive proximity, and the social capital developed among them (Nambisan

[2] The Chemical Abstracts Service (CAS) number is a unique identifier of every chemical substance known in the public domain.

TABLE 1 Overview on circular economy barriers

Level	Barrier	Explication/details	Sources
Individual	Linear thinking patterns and cultural behavior	Thinking in produce-buy-own-waste patterns (e.g., habit of consuming single-use packaging) and aesthetic preferences (e.g., bias against recyclate material due to their shaded color).	Gong, Putnam, You, and Zhao, 2019; Guldmann and Huulgaard, 2020; Kirchherr et al., 2018; Paletta et al., 2019; Vermunt, Negro, Verweij, Kuppens, and Hekkert, 2019
	Lack of CE related knowledge	Lacking CE knowledge and technical capabilities of workers, particularly in SMEs.	Guldmann and Huulgaard, 2020; Kumar, Sezersan, Garza-Reyes, Gonzalez, and AL-Shboul, 2019; Vermunt et al., 2019
	Reservations against CE	Hesitant approach and missing commitment to promote CE internally.	Guldmann and Huulgaard, 2020; Kirchherr et al., 2018; Kumar et al., 2019
Firm	Lacking strategic alignment	Focus on linear economy strategies and a narrow focus of sustainability strategies (e.g., efficiency). This also relates to a reluctance to involve external stakeholders.	de Jesus and Mendonça, 2018; Guldmann and Huulgaard, 2020; Kirchherr et al., 2018; Mont et al., 2017
	Circular knowledge differs from existing organizational knowledge	Institutionalized organizational memory (e.g., behavioral norms and success metrics), lacking organizational knowledge on CE (e.g., circular design, material flows), and difficulties in finding qualified employees hinder firms to implement circularity.	Guldmann and Huulgaard, 2020; Kirchherr et al., 2018; Mont et al., 2017; Rizos, Behrens, Kafyeke, Hirschnitz-Garbers, and Ioannou, 2018; Tura et al., 2019; Vermunt et al., 2019
	Difficult to attain top management support	Reluctance of managers toward sustainability topics due to their conservative and risk averse decision-making behavior.	Guldmann and Huulgaard, 2020; Kumar et al., 2019; Rizos et al., 2018
	Difficult to establish cross-functional collaboration	Silo thinking in departmental structures and routines inhibit effective CE projects.	Boons and Lüdeke-Freund, 2013; Gong et al., 2019; Tura et al., 2019; Guldmann, 2018
	Incentive structure supporting linear business models	Evaluation and performance measurement tools are optimized for a linear economy and lead to misaligned incentives for a CE.	de Jesus and Mendonça, 2018; Guldmann and Huulgaard, 2020; Vermunt et al., 2019
	Higher management complexity and related costs	Increase of transaction costs due to more horizontal and vertical business relationships in the value chain.	de Jesus and Mendonça, 2018
	Cannibalization concerns due to product life time extensions	Repaired, reconditioned, and remanufactured products could decrease sales of new products.	Guldmann and Huulgaard, 2020; Mont et al., 2017
	Product design issues	Current products are not designed for easy disassembly, repair, and remanufacturing. Little attention for end-of-use phase during product design and a lack of design tools for circular solutions.	Guldmann and Huulgaard, 2020; Gong et al., 2019; Kirchherr et al., 2018; Kumar et al., 2019; Mont et al., 2017; Franco, 2017; Veleva and Bodkin, 2018

(Continues)

TABLE 1 (Continued)

Level	Barrier	Explication/details	Sources
	Technological lock-in due to existing long-term investments	Lock-in to existing production infrastructure and limited availability of technologies that can support further lifetimes.	de Jesus and Mendonça, 2018; Kumar et al., 2019; Paletta et al., 2019; Vermunt et al., 2019
	High up-front investments needed	Often substantial initial capital requirements (e.g., new factory equipment or pre-financing of leasing models).	de Jesus and Mendonça, 2018; Kirchherr et al., 2018; Kumar et al., 2019; Mont et al., 2017; Preston, 2012; Rizos et al., 2018
	Additional labor costs	Circular services (e.g., disassembly, repair, sorting, recycling) incur extra labor costs.	Mont et al., 2017;Vermunt et al., 2019
	Difficult access to funding	Shareholders and financiers lack awareness for CE initiatives. Return on investments of CE projects is uncertain and cannot be measured properly with existing key performance indicators.	Bening, Eckle, Prüss, and Blum, 2018; de Jesus and Mendonça, 2018; Guldmann and Huulgaard, 2020; Gong et al., 2019; Vermunt et al., 2019
	Pricing issues and liquidity risks	Uncertainties about the residual value of circular products and pricing models for leasing business models. Leasing cash flows are spread over longer time periods and can incur liquidity risks.	Mont et al., 2017
Value chain	Dispersed, complex value chains	Value chains are dispersed over several tiers and countries with divergent regulations. This hinders alignment and collaboration.	Guldmann and Huulgaard, 2020; Mont et al., 2017; Preston, 2012; Rizos et al., 2018
	Contradicting vested interests and lacking cooperation across the value chain	Incorporating CE practices requires multiple up- and down-stream firms to adjust operations and product portfolio. Limited willingness to cooperate with multiple value chain tiers complicates inter-organizational collaboration (e.g., OEMs' circular business models such as repair might conflict with their suppliers'/retailers' interests).	de Jesus and Mendonça, 2018; Guldmann and Huulgaard, 2020; Kirchherr et al., 2018; Kumar et al., 2019; Mont et al., 2017; Preston, 2012; Vermunt et al., 2019; Bening et al., 2018
	Supply chain lock-in	Contracts and strong dependencies with suppliers not supporting circularity (e.g., either due to non-willingness or lock-in in production facilities optimized for linear concepts).	Kirchherr et al., 2018; Mont et al., 2017; Vermunt et al., 2019
	Underdeveloped supply network	Suppliers with CE competencies or product portfolio are often not available or have still instable process capabilities. Building up new partnerships and mutual trust takes time.	Guldmann and Huulgaard, 2020; Kumar et al., 2019; Mont et al., 2017; Preston, 2012; Tura et al., 2019; Vermunt et al., 2019; Franco, 2017; Veleva and Bodkin, 2018
	Lacking information exchange	Difficulty to trace materials and organize information flows. As firms fear IP infringements and competitive losses, they are reserved against sharing information regarding material composition (including concentrations of hazardous substances).	Gong et al., 2019; Paletta et al., 2019; Preston, 2012; Rizos et al., 2018; Tura et al., 2019
	Low quality of recycling material streams	Technical contamination reduces quality and mechanical performance of recyclates (e.g., material mixes, hazardous additives, multi-layer materials).	Baxter et al., 2017; Bening et al., 2018; Guldmann and Huulgaard, 2020; Kirchherr et al., 2018; Mont et al., 2017; Paletta et al., 2019

(Continues)

TABLE 1 (Continued)

Level	Barrier	Explication/details	Sources
	Limited standardization hinders life time extensions	Lacking standardization (e.g., on components) restricts lifetime extensions like repair services but also deteriorates reverse material streams (e.g., additives contaminating materials).	Baxter et al., 2017; Bening et al., 2018; Kirchherr et al., 2018; Paletta et al., 2019
	Imponderability of organizing product take back	Difficulties in organizing take back logistics, unpredictable volume, and systemic contamination of returned products (e.g., due to end-customer misbehavior, or inefficient collection and sorting systems).	Baxter et al., 2017; Bening et al., 2018; Mont et al., 2017; Paletta et al., 2019; Franco, 2017
	Uncertain market development	Limited market for low quality recyclates; irregular peaks and limited resilience of waste and recycled material markets.	Bening et al., 2018; Guldmann and Huulgaard, 2020; Paletta et al., 2019; Veleva and Bodkin, 2018
	Lacking consumer interest and awareness	Resistance from customers toward circular product offerings are related to perceived lower product value due to past use, loss of ownership, or customers simply not understanding the added value of circular products.	Baxter et al., 2017; Boons and Lüdeke-Freund, 2013; de Jesus and Mendonça, 2018; Kirchherr et al., 2018; Mont et al., 2017; Preston, 2012; Ranta, Aarikka-Stenroos, Ritala, and Mäkinen, 2018; Vermunt et al., 2019
Institutional	Regulatory barriers and administrative burdens	Absence of a binding legislative framework encouraging companies to pursue circular innovation. Policies incentivize recycling, or incineration over higher level circular strategies such as reuse and refurbishment. Also inconsistent regulations regarding waste, by-products, and secondary materials.	Bening et al., 2018; Guldmann and Huulgaard, 2020; Kirchherr et al., 2018; Kumar et al., 2019; Mont et al., 2017; Paletta et al., 2019; Rizos et al., 2018; Tura et al., 2019
	Inappropriate taxation on resource use	Low taxes on primary raw materials but high ones on labor costs hinder R-strategies and lead to price differences between virgin raw materials and recycled materials.	Bening et al., 2018; Guldmann and Huulgaard, 2020; Kirchherr et al., 2018; Mont et al., 2017; Preston, 2012
	Lack of institutional support for CE	Missing eco-design guidelines, lacking subsidies for scaling-up CE solutions, or unsustainable public procurement policies.	Bening et al., 2018; Gong et al., 2019; Guldmann and Huulgaard, 2020; Kirchherr et al., 2018; Kumar et al., 2019; Paletta et al., 2019; Rizos et al., 2018; Veleva and Bodkin, 2018

Note. CE = circular economy; SME = small and medium sized enterprise; OEM = original equipment manufacturer; IP = intellectual property.

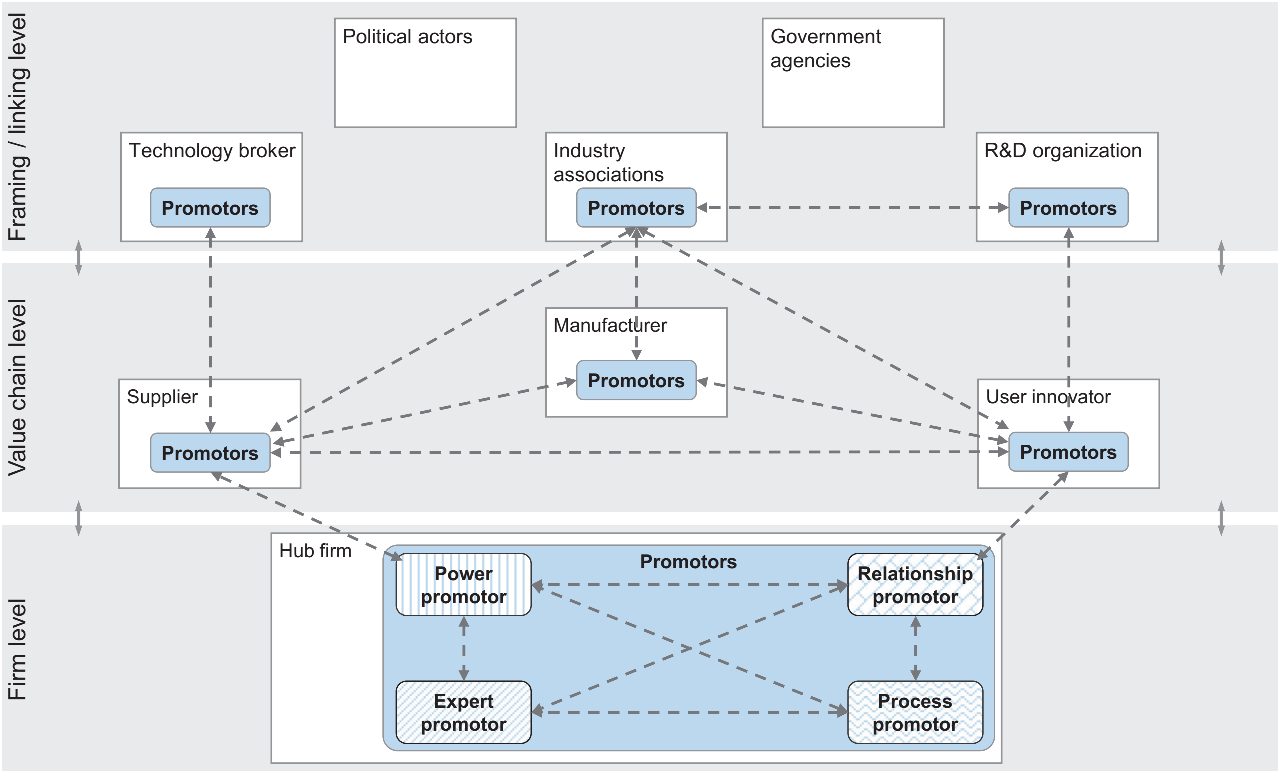

FIGURE 1 Generic innovation promotor community (based on Fichter, 2009)

& Sawhney, 2011; Velenturf & Jensen, 2016). Based on Witte (1973, 1977), community theory takes these microlevel perspectives a step further and theorizes about the close but informal collaboration of individual promotors or champions in overcoming complexity and innovation barriers (Hauschildt & Kirchmann, 2001).

2.4.1 | Levels of innovation communities

Fichter (2009) developed a multilevel promotor concept of *innovation communities* in the sustainability context (see Figure 1). Similar to the multiple levels of CE barriers, innovation communities consist of individuals on three levels (Fichter, 2009; Klerkx & Aarts, 2013):

- The *firm level* is represented by the hub (or focal) firm which is the orchestrator of a goal-oriented, hub-and-spoke innovation network (Dhanaraj & Parkhe, 2006; Paquin & Howard-Grenville, 2012). It covers employees from R&D and other functions with a stake in the innovation process. In the context of this paper, the goal is to develop C2C products.
- The *value chain level* consists of actors further upstream (i.e., suppliers) and down-stream. In CPI this includes loop-closing firms such as collectors and recyclers. Suppliers may act as loop-closing firms themselves by diversifying their material sources through partnerships with downstream actors (Boons, 2002).
- The *framing and linking level* includes actors facilitating the innovation process such as intermediary organizations and related consultants as well as broader interest groups (e.g., industry associations). Innovation intermediaries are well known entities in innovation management (Howells, 2006), but even more important in environmental innovation (de Marchi, 2012), sustainability-oriented innovation (Clarke & Roome, 1995; Gliedt, Hoicka, & Jackson, 2018; Hansen & Klewitz, 2012; Klewitz, Zeyen, & Hansen, 2012), sustainability transition (Mignon & Kanda, 2018), and industrial ecology (Boons & Baas, 1997; Boons, Chertow, Park, Spekkink, & Shi, 2017; Patala et al., 2020; Zaoual & Lecocq, 2018). Intermediaries "assist the other promotors in achieving more focus in the vision they aim to realize" (Klerkx & Aarts, 2013, 206), create trust as basis for relationship building and knowledge exchange, and can coordinate a network of firms efficiently (Walls & Paquin, 2015). Two types of intermediaries exist: those acting on *neutral ground* (Howells, 2006) to connect actors (Klewitz et al., 2012; Patala et al., 2020), and more *interest-driven* ones, "getting their hands dirty" as "architects of collective exploration" (Agogué, Yström, & Le Masson, 2013, 17). They may even actively direct partners to the desired sustainability outcome, sometimes even being the source of the innovation themselves (Agogué et al., 2013). Often they are challenged to strike a balance between being a hands-off facilitator and a proactive change agent (Klerkx & Aarts, 2013). Standard-setting

bodies are also important intermediaries for the (voluntary) self-regulation of industry (Howells, 2006). Rossi, Charon, Wing, and Ewell (2006) highlight the role of close collaboration with assessors of the C2C certification system. Besides intermediaries, the framing and linking level also covers political and regulatory bodies supporting and constraining innovation (Fichter, 2009).

While Fichter's model above provides a static perspective, more recently interest has emerged in community dynamics by looking into how innovation communities develop over time (Kokoulina et al., 2019; Muzzi & Albertini, 2015).

2.4.2 | Types of promotors

To overcome barriers, firms need promotors. They are defined as "individuals who actively and intensively support the innovation process" (Fichter, 2009, 359). Five types of promotors exist (Fichter, 2009 based on earlier classifications by Chakrabarti & Hauschildt, 1989; Gemünden & Walter, 1995; Witte, 1977; see also Muzzi & Albertini, 2015):

1. The power promotor pushes innovation through hierarchical power.
2. The expert promotor contributes through expert knowledge.
3. The process promotor has deep knowledge about the organization, knows who is affected by an innovation, and is able to translate the different languages spoken in the firm.
4. The relationship promotor (or network champion Klerkx & Aarts, 2013) facilitates building up innovation-related relationships inside and outside the company.
5. The universal promotor performs both power and expert roles and combines them with process and/or relationship roles in one person. Such promotors can be critical for overcoming barriers.

2.4.3 | Collaboration in the innovation community

An innovation community usually emerges around a specific, often radical, innovation project (Fichter, 2009; Muzzi & Albertini, 2015), but it may be extended in follow-up projects. Generally, the community is characterized by social cohesion and trust, with promotors considering themselves a team to achieve joint goals (Klerkx & Aarts, 2013). It is based on actor learning and multidisciplinary ways of problem solving (Leising, Quist, & Bocken, 2018). Good communication structures for exchanging information and knowledge help to access complementary competences and resources. Even though promotors are intrinsically motivated, they need the community to acquire mutual support as they often face hard opposition (Fichter, 2009).

We are interested in the distinct collaboration mechanisms within an innovation community for CPI. A mechanism is "a process in a concrete system which is capable of bringing about or preventing some change in the system" (Bunge, 2004 see Hedström & Ylikoski, 2010, 51). When analyzing collaboration, distinguishing between cooperation and coordination seems expedient (Gulati et al., 2012). Cooperation is about jointly pursuing agreed-on goals, contributing resources such as knowledge, and sharing benefits. It is a behavioral outcome of partners' motivation and commitment (Gulati et al., 2012). Coordination refers to aligning actions and facilitating information sharing, for instance, through joint structures and processes. High task uncertainty requires more extensive forms of coordination (Gulati et al., 2012).

Overall, we look at how cooperative and coordinative collaboration mechanisms between promotors in an innovation community—spanning across organizational, value chain, and framing/linking levels—help to overcome CPI barriers. We elaborate this perspective in an in-depth case study of a successful C2C innovator.

3 | METHODS

3.1 | Research design

As we categorize CPI processes as a nascent research phenomenon (Edmondson & McManus, 2007), we chose a qualitative research design. We conducted a longitudinal embedded case study of C2C product development. It covers several related projects across a time frame of 10 years on multiple levels of analysis (individual promotors distributed across the hub firm, value chain partners, and framing/linking levels). This approach leads to a unique and rich dataset. When studying longitudinal phenomena, a single case study is appropriate (Siggelkow, 2007) as it allows to uncover the complexity of how individual promotors interact in and across organizations over time. In contrast to Eisenhardt's (1989) focus on multiple cases, single cases allow setting the discovered constructs into a richer context and a good story (Dyer & Wilkins, 1991).

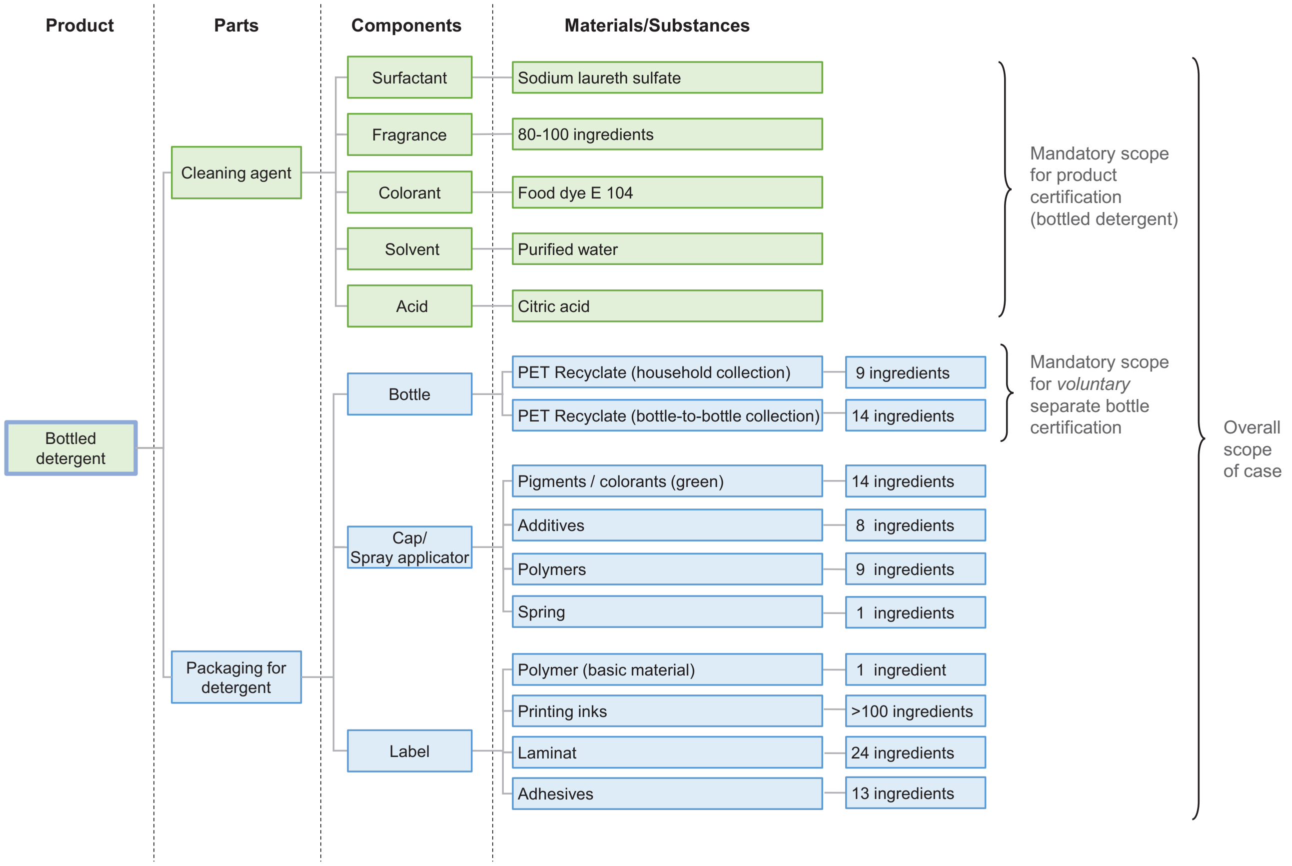

FIGURE 2 Composition of bottled detergent (with relevant parts, components, and materials/substances)
Note. PET = polyethylene terephthalate.

3.2 | Case selection

As our hub firm we selected the large (1,050 employees) owner-managed family business W&M—a frontrunner of circularity in the household chemical industry. W&M has become an eco-pioneer in its industry as early as the 1980s with the introduction of its *Frosch* brand. Since then, it has been optimizing the human and eco-toxicological profile of its detergents (products of consumption) for safe biological cycles, that is, complete biodegradation in the water system. The brand achieved remarkable growth rates since 2005 (Werner & Mertz, 2017, 106). They adopted C2C in 2011 for a pilot product, making the firm one of the first with an explicit circular strategy. Their first C2C-certified product, the *Spirit Glass Cleaner*, was awarded best in class by the leading German consumer advocate organization *Stiftung Warentest* (Werner & Mertz, 2020). After the pilot, W&M rolled out C2C across its product portfolio. In line with its strategic positioning as a sustainability leader, on top of the detergent—which would suffice for receiving a C2C certification—W&M also redesigned its packaging for sound technical cycles with the goal of leading the industry. Figure 2 provides an impression on the complexity of gaining full material transparency and the scopes of mandatory and voluntary certification. Overall, W&M can be considered an "extreme" case, worth documenting (Yin, 2014, 50).

3.3 | Data collection

We conducted semi-structured interviews with internal and external experts involved on all levels of the innovation process. We started with the innovation manager, who introduced C2C to the hub firm and then, using snowball sampling, moved on to relevant internal actors, external partners, and certification bodies. The interviews were transcribed and reviewed by informants. We complemented the formal interviews with protocolled informal ethnographic interviews and observations during site visits and industry events (Munz, 2017). An extensive set of archival documents was also analyzed. We triangulated data from these multiple sources to better ground the timeline of events (Table 2). We collected data both ex-post (covering the years 2011–2015) and in the making of the innovations (2016–2020) to increase credibility, because informants may not be able to fully reconstruct events after longer time periods.

TABLE 2 Data sources

Data type	Quantity	Type of documentation
Formal interviews[a]	**19**	**Transcripts**[b]
Hub firm	7	
Suppliers and partners	3	
Assessor, certification body, consultant	4	
Other industry experts	5	
Informal ethnographic interviews	**15**	**Protocols**
Hub firm	6	
Suppliers and partners	3	
Assessors, certification body, consultant	6	
Focus groups	**1**	**Protocol**
Archival documents	**75**	**Source files**
Publicly available information	30	
Corporate publications (e.g., sustainability reports, environmental policy statements)	8	
Press releases	14	
Media articles	11	
Internal documents (work files, presentation slides, organization charts)	15	
Observations	**10**	**Protocols**
Site visits	4	
Ethnographic observation of industry events (e.g., C2C Congress)	6	

[a]Average length of 1:30 hr; [b]reviewed by informants.

3.4 | Data analysis

Our analysis first focused on creating a timeline of events. We used Yin's explanation building technique to create "a presumed set of causal sequences" in order to answer "'how' or 'why' some outcome occurred" (Yin, 2014, 147). This involves deductive and inductive steps in an iterative process including tentative theoretical propositions, comparing the data with the propositions, revising them, and repeating this as many times as needed (Yin, 2014). Our a priori theoretical understanding stems from innovation community theory, including the multiple levels of analysis, types of promotors, and innovation barriers. By using established constructs, we were not only able to elaborate theory by adding detail (Vaughan, 2000), but also to link our findings to extant literature in the field of innovation management (Fichter, 2009) and industrial symbiosis (Kokoulina et al., 2019) to increase external validity (Gibbert, Ruigrok, & Wicki, 2008; Yin, 2014).

We abductively combined a-priori with open codes. Two researchers were involved in the process to prevent bias: the author who was more deeply immersed in the field focused on the rich description of data. Intermediate results were frequently discussed with the senior researcher who was only selectively involved in fieldwork and therefore was in the role to ensure internal consistency and external validity. Discrepancies in the analysis were resolved when both authors reached a consensus understanding. Preliminary analyses were member-checked by individual participants and in focus groups to increase trustworthiness (Guba, 1981).

4 | RESULTS

We present how W&M developed an innovation community of promotors who applied various collaboration mechanisms to set aside, in this sequence, individual, firm, value chain, and institutional-level CPI barriers (see Figure 3). Our results are structured along this sequence of barrier types as perceived by the hub firm. However, the barriers occur recursively: for instance, the same type of individual and firm-level barriers resolved by the hub, may later be faced by the hub's partners in the value chain. The innovation community consists of thirteen promotors residing within and beyond the organization (see Table 3). Their role was consistently highlighted by relevant actors:

> *For innovative projects you can have good technical, organizational, and economic concepts – all are important! But if you don't have determined actors who tackle it with a certain communicative skill, it won't work. (Head of recycling technology, Packaging collection scheme)*

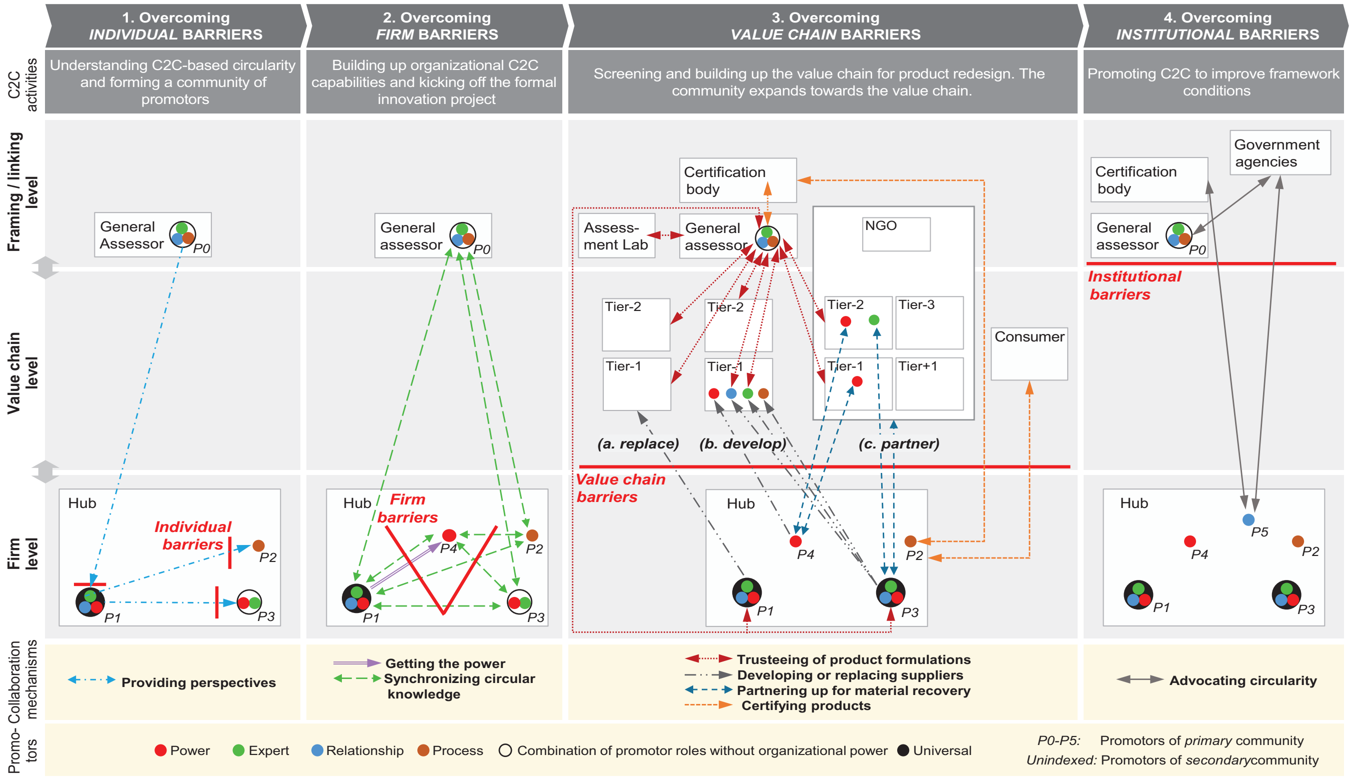

FIGURE 3 Cradle-to-cradle innovation community with collaboration mechanisms to overcome circular economy barriers
Note. Depending on firm circumstances and value chain configuration, (a) to (c) indicate alternative collaboration settings.

4.1 | Step 1: Promotors overcoming individual level barriers

The complexity involved in circularity is often not fully understood by all relevant employees or sometimes marginalized as hoax—this impedes the further organizational assimilation of the concept and stops inventions early on. For overcoming individual level barriers, promotors *provide perspectives* to help other actors understand circularity.

4.1.1 | Providing perspectives

When W&M's head of product development read McDonough and Braungart's (2002) book on C2C in 2005, he did not see the concept's value going beyond safe cycling in biological systems—a standard of W&M's products since the Frosch brand's foundation in 1986. Only a discussion at an industry event—where the consultant from the general assessor of the C2C certification system provided him with a new perspective on product (and packaging) design, combining biological and technical cycles—made him realize the full potential of C2C. He turned into a strong (universal) promotor and subsequently provided this new perspective to selected colleagues. This included the head of packaging development, an expert for bio-based plastics, recently hired to improve W&M's packaging. Right away, he was confronted with the fact that his competences would no longer fit when switching from a bio-based to a recycled packaging strategy. But the combination of biological and technical loops made sense to him. With the power of his position, existing network in the packaging industry, and increasing expertise in recycled packaging, he turned into a second universal promotor. He triggered his employees to develop new competencies in circular thinking and their readiness for internal CPI collaboration:

> *First of all, my staff has to understand why we are doing all this. Certainly, they aren't as deep in the matter as I am, but a basic understanding is important. We do many things differently from classic packaging development. (Head of packaging development, W&M)*

4.2 | Step 2: Promotors overcoming firm level barriers

Organizational resources and structures are in most firms optimized for linear product concepts, inhibiting initiatives for circularity. W&M managed to overcome these barriers and develop related organizational capabilities through the collaboration mechanisms *getting the power* and *synchronizing circular knowledge across boundaries.*

TABLE 3 Mapping and contribution of promotors

Level	Promotor	Promotor type: Expert	Power	Process	Relationship	Universal[a]	Main contribution
Hub firm *W&M*	Head of product development (P1)[b]	x	x		x	x	Introduced C2C to W&M and promoted it in the firm.
	Head of sustainability (P2)			x			Pushed excellence in site-specific certification criteria and managed certification process.
	Head of packaging development (P3)	x	x		x	x	Built up a C2C network in packaging value chain and shared C2C knowledge there.
	CEO (and owner) (P4)		x				Supported C2C also when it seemed too radical for customers.
	Head of corporate affairs (P5)				x		Lobbied for better circular products and packaging regulations at national and EU levels; engaged in dialogue with certification system and industry associations.
Value chain							
- Supplier *Setting b*[c]	Key account manager				x		Understood strategic benefits of C2C project and made it a top management priority.
	Head of sustainability			x			Marketed project internally to assure necessary funds, allocated and coordinated internal activities.
	CEO		x				Decided to conduct C2C product redevelopment project and allocated necessary funds.
	Head of production	x					Redeveloped product formula and production processes.
- Partnership *Setting c*	Head of recycling technology (Tier-2)	x					Had the technical ideas for capturing higher-quality recyclate and pitched project to his superiors.
	CEO (Tier-2)		x				Understood strategic benefits of the recyclate project and authorized the project.
	CEO (Tier-1)		x				Understood strategic benefits of the recyclate project and supported stronger strategic focus on recyclate in the firm.
Framing/linking General Assessor	Consultant (P0)	x		x	x		Guaranteed intellectual property of value chain firms and supported community through C2C expertise and contacts.

[a]A universal promotor is defined as taking on at least three promotor roles simultaneously: expert promotor, power promotor, and either process or relationship promotor. [b]Abbreviation of promotors in results framework in Figure 3 (only primary community is abbreviated). [c]Settings refer to alternatives specified for overcoming value chain barriers in Figure 3.

4.2.1 | Getting the power

In the early stage of the CPI process, it is significant to get the power from higher hierarchical levels for strategic decision-making and releasing necessary funding for the innovation project. As W&M's CEO was searching a strategy for sustainable packaging, the head of product development advanced the potentials of C2C for using biodegradable materials for the detergent (biological cycle) and recycled plastic for its packaging (technical cycle). This convinced the CEO of the strategic alignment of C2C, turned him into the key (power) promotor, and made him promote a vision of W&M as the first fully circular firm in its industry:

Our CEO is the one who drives C2C. It is his company, when he says we do that now, then it is done, and everybody gets involved. (Head of sustainability, W&M)

4.2.2 | Synchronizing circular knowledge across boundaries

To overcome the lack or inconsistency of organizational knowledge, synchronizing circular knowledge across functions and organizational boundaries furthers the assimilation of circularity in the firm. The early promotors explored the meaning of C2C in intensive cross-functional learning processes, including informal occasions such as lunch breaks. The promotors accomplished a high traction for the C2C project, together overcoming partially restrictive mindsets of further relevant colleagues and creating a joint knowledge base. This lifted the understanding of circularity from selected individuals, over the group of promotors, to organizational-level knowledge. Several of these learning activities were in cooperation with the consultant (intermediary) for instance, through facilitated C2C workshops. As senior expert for C2C, he helped W&M's newly created CPI core team to lead an in-depth discussion about C2C-based circularity.

The nature of this boundary spanning and cooperation-based mechanism becomes clear when looking into the initiation of the *Ink Project*. It took the promotors 2 years of learning to fully understand the challenges for circulation of the product label's inks—even though these were already plant-based and considered "ecofriendly". During this period, the heads of product and packaging development had many discussions with the consultant and the CEO about C2C's new approach toward eco-assessment. While existing programs, like REACH, is largely based on self-regulation based on relatively large thresholds for a narrow list of substances of very high concern, in C2C's absolute approach even small amounts of a much broader list of substances of concern are banned completely or must be phased out from the product formula in defined timeframes.

4.3 | Step 3: Promotors overcoming value chain barriers

Considering C2C's demand for material quality and circularity, many barriers are related to engaging with partners across complex and dispersed value chains. The innovation community eliminated these through the collaboration mechanisms *trusteeing of product formulations*, *developing or replacing suppliers*, *partnering up for material recovery*, and *certifying products*.

4.3.1 | Trusteeing of product formulations

C2C requires toxicological assessments for all substances and components of a product with documentation through product specifications, bills of materials, material safety datasheets, and production processes materials lists (see product composition in earlier Figure 2). As this is often proprietary information touching on firms' competitive position, refusal to provide it can turn into a major barrier. Trusteeing of product formulations is a coordinative mechanism that supports the mobility of such knowledge when its competition-critical nature prevents its direct exchange between value chain actors.

Normally C2C fails due to missing transparency in the supply chain. The consultant was a great help because with him acting as a trustee we received the necessary information suppliers would have never given us otherwise. In the case of the packaging, we would not have gone that far without him. (Head of product development, W&M)

The mechanism is a form of mediated coordination by the consultant who—as a process, relationship, and expert promotor—brokers knowledge between hub firm, suppliers, material health assessment lab, and the certification body by means of strict and detailed non-disclosure agreements (NDA) valid throughout the innovation project (and beyond, depending on the nature of the contracts). The mechanism creates transparency in complex supply chains while avoiding potential misappropriation of critical knowledge. Overall, it helps to overcome ignorance of materials' chemical footprint throughout the value chain and framing/linking levels.

4.3.2 | Developing or replacing suppliers

The results of the material health assessment, if indicating non-compliance, usually trigger decisions on the optimization of materials, even leading to a reconfiguration of the value chain. The promotor community's next step was to convince the suppliers to omit or change substances of concern. While ideally suppliers would simply follow their customer's requirements, given the considerable efforts required to implement C2C improvements, this was usually not the case. Instead, W&M mostly had to develop or replace suppliers. Depending on the supply chain tier and supplier-specific circumstances, promotors from firm and framing/linking levels exerted their influence to different degrees. The suppliers learned about the task W&M expected them to do, while the community learned about the partner's capabilities and commitment. If necessary, the promotors supported the C2C-related capability development through synchronizing circular knowledge. Still, suppliers did not always commit to the CPI project—often they were just uninterested or hesitant to invest any resources for reaching C2C quality of their materials. In consequence, if the material was non-critical, W&M simply decided to drop it from the formula. In the other cases, existing suppliers were replaced (Figure 3, setting a) or developed (setting b).

4.3.3 | Partnering up for material recovery

W&M aimed at using mixed post-consumer plastic waste as a source for recycled packaging; however, there was no recyclate supply available in the desired quality when they started the project. In general, market availability for cycled products, components, and materials is a major barrier for CPI. Consequently, W&M partnered up for material recovery by creating the Recyclate Initiative (Figure 3, setting c). The cross-sector partnership aimed at developing, producing, and recovering materials and comprises the entire recyclate value chain: a national packaging collection scheme, a machine builder for high-tech sorting technology, a bottle producer, a retail chain, and an environmental NGO. When W&M invited tenders for high-quality post-consumer recyclate, a sustainability enthusiast from the national packaging collection scheme seized this opportunity to propose higher value creation activities through closed material loops to his bosses. Something he had proposed and failed with before, was finally accepted due to the prospective customer's positive image and demand pull. The resulting intensive cooperation across the value chain enlarged the innovation community with additional promotors from the various partner organizations.

4.3.4 | Certifying products

A further value-chain barrier is to raise customer awareness and excitement for the circular and health characteristics of the redesigned product and thus profit from the (radical) innovation. To inform customers, W&M considered certification (and related labeling) the solution because while the composition of the product (mainly its packaging) had changed quite substantially, its outer appearance had not changed at all—resembling the fact that environmental features often remain unrecognized by customers (de Marchi, 2012; Kanda, Hjelm, Clausen, & Bienkowska, 2018).

The mechanism certifying products describes the coordination necessary to achieve the final product certification[3] in order to inform customers about the new product characteristics. To apply for the certificate, the head of sustainability—process promotor for the overall C2C certification—coordinated the necessary documentation. Besides the material health and product reutilization data, he coordinated the site-specific criteria (i.e., water stewardship, renewable energy and carbon management, and social fairness) with the respective departments and the certification body. For these criteria, he could revert to information from existing management systems and performance indicators (e.g., EMAS, ISO 50001) and the firm's social programs. While consumers were still unfamiliar with the rather new C2C label, it served to communicate the extended product quality to retailers and professional buyers (e.g., from cleaning services valuing employee health and safety). Though initially leading to doubts at W&M whether the C2C label would be beneficial to the brand (or the other way around), the certification ultimately strengthened W&M's positioning as a pioneer in the market and industry.

4.4 | Step 4: Promotors overcoming institutional barriers

The broader market framework usually favors the status quo (e.g., low prices for primary raw materials) and hinders the broader diffusion of CPI. Through *advocating circularity*, the innovation community seeks to overcome institutional-level barriers and promote favorable conditions for CPI.

4.4.1 | Advocating circularity

The CEO realized that advocating circularity is important and goes beyond what he can do himself. He created the position of a public affairs manager and tailored it to an employee from the innovation network who had suggested the demand for such a position. This employee serves as a relationship promotor for advocating the firm's circular activities to regulatory agencies:

[3] The Cradle to Cradle Products Innovation Institute offers both a full certification (based on the five criteria material health, material reutilization, renewable energy and carbon management, water stewardship, and social fairness) and a material health certification covering only the first criterion.

> *I have a network, I put certain topics into this network, with positions from us. And then I try to feel a bit the opinion where certain developments are going, but also to bring us into discourse … and to say "We can do it!"* (Public affairs manager, W&M)

The public affairs manager also developed a closer relationship to the certification body by becoming a member in their stakeholder advisory council. He provided feedback on W&M's experiences with the certification and cooperated in testing the new standard version 4.0 on its practicability before its release. In case of recycled PET packaging, W&M plead for improvements: the requirements for material health and product circularity were contradictory because recyclates usually contain fractions of substances that the C2C standard requires to be eliminated from the product (e.g., antimony used as a catalyst in PET production). This led the certification body to integrate their objections into the revised standard version (C2CPII, 2019, 27).

5 | DISCUSSION

5.1 | A framework for collaboration mechanisms in CPI processes

In this study, we provide a unique longitudinal and micro-level analysis of how W&M has built an innovation community with promotors collaborating for CPI. The community helped W&M to overcome structural constraints in and across organizational boundaries (Klerkx & Aarts, 2013) and set aside related innovation barriers. As contribution, we specified eight collaboration mechanisms explaining how the promotors sequentially resolved individual, firm, value chain, and institutional-level CPI barriers (see Figure 3; Table 4). These mechanisms can be understood as the "cogs and wheels of the internal machinery" (Hedström & Wennberg, 2017, 93) of the community.

From a hub firm's perspective, the four types of barriers occur in a linear fashion. But as innovation communities evolve, circularity penetrates deeper into the value chain and barrier types reoccur (thereby aggravating the hub firm's value chain barriers). The collaboration mechanisms originally used in the hub firm now unfold in partner organizations in a similar manner. This represents a recursive process comparable to the trickle-down or green multiplier effects known from supply chains (Harms, Hansen, & Schaltegger, 2013; Preuss, 2001).

Most of these collaboration mechanisms facilitate mutual trust, learning, and capability building for implementing C2C. Regarding the two facets of collaboration (Gulati et al., 2012), they strengthen the cooperation in the community. We also identified critical mechanisms with coordinative functions, which are particularly important for overcoming interorganizational barriers in the CPI project.

5.2 | Coordinative mechanisms as enabler for collaboration across the value chain

Overcoming interorganizational barriers is of utmost importance for CPI. Two of the collaboration mechanisms stick out here: trusteeing of product formulations and certifying products. Together they provide specifications, common language, and adequate communication channels for the collaborative innovation activities.

5.2.1 | Certification as coordinative function in the innovation community

The C2C label is important because it communicates a product's circular properties to customers and results in market differentiation. But it is the actual certification process (i.e., the *certifying products* mechanism) which fulfills a coordinative function within the innovation community and related organizations. It is based on the highly formalized C2C standard (C2CPII, 2016) including terminology, goals, specification of criteria, and operational rules. Accordingly, the standard has both syntactical and semantical characteristics and serves as a boundary object across functions and organizations (Carlile, 2002). Based on clear form-based communication structures between the firms, intermediary, assessment lab, and certification body the product architecture is verified in the value chain stage of the community. But the standard influences the promotors already in the previous stages of the community by giving guidance for product design early on in the innovation process. We therefore propose that certifying can be considered the central coordinative mechanism of the CPI community. Certifying partly depends on trusteeing.

5.2.2 | Trusteeing as coordination of sensitive information flows across boundaries

The C2C standard demands the elimination of technical contamination from materials and therefore requires close collaboration with suppliers. In marked contrast to the required openness for CPI (Franco, 2017; Patala et al., 2020), nontransparent value chains, ignorance of material compositions, and fear of intellectual property infringements show that actors in the value chain operate in rather closed ways. The intermediary solves this

TABLE 4 C2C promotor collaboration mechanisms to overcome individual, firm, value chain, and institutional barriers

Level	Collaboration mechanism: Name	Description	Active promotors	Facet	Barriers (examples)[a]
1. Individual	Providing perspectives	Sharing insights about what a closed-loop production system means in the C2C context and further developing individual skillsets.	- Process, relationship & expert - Universal	Cooperative	- Restrictive mindset - Lack of competences
2. Firm	Getting the power	Addressing higher management levels to gain support for circular innovation projects.	- Universal	Cooperative	- Lacking strategic alignment - Missing management support - Lack of in-house resources - Higher costs of C2C materials
	Synchronizing circular knowledge	Aligning circular knowledge through cross-functional and interorganizational collaboration.	- Process, relationship & expert - Universal - Power - Process	Cooperative	- Lack of or divergent knowledge - Unfitting organizational structure - Functional silos
3. Value chain[b]	Trusteeing of product formulations	Coordinating NDA-secured information sharing of material compositions to achieve required material transparency in the value chain.	- Process, relationship & expert	Coordinative	- Lack of information on material composition and SoC - Fear of IPR infringements
	Developing or replacing suppliers	Sharing knowledge with suppliers to develop their circular capabilities. In case of lacking cooperation in the innovation project, components are omitted or suppliers replaced.	- Universal - Process, relationship & expert	Cooperative	- Absence of C2C conform materials and substitution options - Supply chain inertia - Lack of knowledge in value chain - Contamination of recyclates
	Partnering up for material recovery	Building partnerships with organizations to recover and reprocess products and their inherent components and materials with the goal to keep them circulating in the same value chain (i.e., closed loops).	- Universal - Power - Process, relationship & expert	Cooperative	- Unavailability of quality recyclates - Immature supply/recovery chains - Cost optimized global value chains - Rigid retail specifications and perceived consumer expectations
	Certifying products	Coordinating the verification of overall product compliance with all C2C certification criteria; the resulting quality label informs customers.	- Process - Process, relationship & expert	Coordinative	- Lack of information on SoC - Lack of customer awareness/acceptance
4. Institutional	Advocating circularity	Advocating favorable framework conditions regarding CE with regulatory bodies and self-regulatory standard-setting bodies.	- Relationship	Cooperative	- Existing regulation favors linearity - Low prices of primary raw materials

C2C = cradle to cradle; IPR = intellectual property rights; SoC = substances of concern; NDA = non-disclosure agreement.
[a]Table 1 shows a full barrier list; [b]Through recursive processes in the hub's partner organizations, individual and organizational-level barriers and collaboration mechanisms reoccur.

paradox by establishing formal communication infrastructures between partners based on contracts and NDAs, thus enabling a secure information exchange for the assessment of a product's toxicological composition. Instead of openness, we suggest knowledge mobility (Dhanaraj & Parkhe, 2006) be the more appropriate construct. Basically, trusteeing can be considered a syntactic mechanism that helps coordinating quality information exchange based on a standardized communication (Carlile, 2002; Randhawa, Josserand, Schweitzer, & Logue, 2017) and ultimately enables cooperation in the community.

The downside of trusteeing is that confidentiality agreements at times also hindered the broader diffusion of C2C-conform materials, as their availability cannot be communicated openly in the market. The strict NDAs also inhibit an independent validation of the approach and represent an ongoing dilemma in CPI (de Koeijer et al., 2017; Rossi et al., 2006; Toxopeus, de Koeijer, & Meij, 2015) and industrial ecology more broadly (Patala et al., 2020). Future research could explore how to best contain these adverse effects.

5.3 | The intermediary as co-orchestrator of the innovation community

Our findings show that the intermediary is important for both cooperative and coordinative facets of collaboration in the innovation process. As shown in the previous section, the coordinative mechanisms certifying and trusteeing center around the intermediary in his role as assessor for the C2C certification and coordinator of secure information transfer. Regarding the other, cooperative mechanisms, he proactively supports the learning process about C2C by expertise, workshop facilitations, and inspiration of promotors to achieve a certain C2C quality level. To overcome structural holes in the innovation network, he involves in matchmaking with relevant partners or, if necessary, articulates new demand for circular materials on a broader industry level. By overcoming the barrier of non-responsibility (Hauschildt & Kirchmann, 2001) in deeper value chain tiers, he supports change across the value chain.

Given the intermediary's strong contributions to cooperation and coordination, he—together with the promotors in the hub firm—can be considered as belonging to the primary community which serves as an aggregated orchestrator of the overall innovation network (Klerkx & Aarts, 2013). Still, the intermediary did not take away ownership from the hub firm, even when he sometimes crossed the boundary from a neutral to an interest-driven innovation-producing actor (Klerkx & Aarts, 2013). We found that this role ambiguity was actually an asset, because as an insider of the certification system the intermediary was highly knowledgeable, experienced, and motivated to lead the project to success. This is also supported by Drabe and Herstatt (2016), who found a positive relationship between a company's satisfaction with C2C implementation and the involvement of certification partners.

5.4 | Limitations

Our findings emerged from an extreme and thus unrepresentative case company voluntarily redeveloping its products far beyond the requirements of the C2C standard. Still, we expect our contributions to be transferable (Shenton, 2004) to second movers because innovation communities are also needed when implementing CPI at a slower pace. Second, the comprehensive multi-level perspective applied here comes with the drawback that organization-internal processes cannot go into detail. Studies analyzing collaboration in the innovation community with an exclusive focus on the firm-level change processes would complement our perspective (e.g., Roome & Louche, 2015). Third, in our study, several individuals took multiple promotor roles. This might be due to the hub's family-firm context and relative smallness among large companies. Larger multinationals may have a higher degree of role specialization and hierarchical distance. Fourth, the identified collaboration mechanisms emerged from a specific context and may not be exhaustive. Moreover, some mechanisms such as trusteeing of product formulations might be particularly relevant to C2C due to its requirements on material health and may still lack in other circular settings. Therefore, the mechanisms represent a theory of the middle range (Merton, 1968) with explanatory relevance in its specific context (Hedström & Wennberg, 2017).

5.5 | Implications for practitioners

Innovation communities are decisive for companies to overcome CPI barriers at multiple levels. First, this study indicates that companies wishing to implement CPI require an initial set of promotors in the upper middle management to build up circular competences and then become boundary spanners to expand the community across the value chain. In order for such promotors to emerge, it appears fruitful to provide guidance by circular company strategies, the freedom to innovate, and top management support. Second, given the complexity of the value chain, providing resources for matchmaking by an intermediary can become critical for growing a promotor community with the necessary coverage. Third, for sustaining community spirit, keeping motivation despite drawbacks is important. While to some extent purpose seems to be intrinsic to C2C, celebrating partial successes and regular reinforcement by top management—as in change initiatives more broadly (Doppelt, 2010)—is needed.

5.6 | Implications for policy-makers

Given the importance of networking across the value chain and the key role of intermediation in CPI, government agencies could increase funding for public and public–private intermediation for product-level circularity. This would support companies interested in C2C-based circularity, but lack resources for a transformation of their value chains. Also, the government could become a network ombudsman (Baumann, Boons, & Bragd, 2002) itself by establishing own network administrative organizations (Klerkx & Aarts, 2013). By the impartial position of the public sector, governments would be in a good position to reduce the risk of bias linked to intermediaries with vested interests. Successful programs such as UK's National Industrial Symbiosis Program (Paquin & Howard-Grenville, 2009) or ECOPROFIT (Hansen & Klewitz, 2012) could serve as templates.

6 | CONCLUSION

Applying innovation community theory to CPI processes of a CE frontrunner allowed us to get a microlevel understanding of how individual promotors collaborate across the value chain. The promotors use both cooperative and coordinative collaboration mechanisms to drive C2C through the value chain, build up knowledge on circularity, and collectively overcome implementation barriers on individual, organizational, value chain, and institutional levels. Ultimately, collaboration within the innovation community intensified in numerous iterations of subsequent CPI projects. While time elapses, the scope of the overall community changes, as do the intensities of the relationships among promotors and supporters, and the type and combination of collaboration mechanisms. Moreover, recursion occurs in the deeper levels of the value chain. A company that is aware of the complexity of CPI and has the ability to systematically develop the necessary innovation community as a vehicle for the overall network orchestration, will be in a good position to overcome barriers and successfully introduce CPIs in the market.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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