

Designing the Internal Organization for Circular Economy Innovation: A Knowledge Governance and Microfoundations Approach

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Abstract

The ecological impacts of industrial products are often locked in at the material design stage, requiring transformative changes to practices, mindsets and systems from the beginning of the innovation journey. This paper critically explores how such transformative shifts are being shaped by the application of regenerative principles to material design and innovation practices in the realm of entrepreneurship. It is based on a qualitative interview study with 12 material innovation companies. The study aims to understand the novel innovation practices they are fostering to catalyse regenerative and/or circular approaches that can address global plastic pollution – a major contributor to global GHG emissions. The analysis identifies seven perceived innovation barriers that complicate the full adoption of regenerative principles, including advocating for new product categories, educating B2B customers about novel materials and inventing appropriate scaling approaches. Overcoming these barriers requires mindset-related and systemic transformations, linking this research to broader innovation management, sustainability transitions and regeneration debates. The article concludes by articulating key insights and managerial implications for innovation leaders who are keen to further regenerative transitions through material innovations within (and beyond) their own organisations.

Keywords: Regenerative Design, Biomaterials, Material Innovation, Plastics, Systems Design, Sustainability Transitions, Innovation Barriers.

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1 Introduction

Firms adopting circular economy (CE) principles require significant changes to existing governance forms, organizational processes, and practices. Despite the nascent nature of CE research in management and innovation literature, recent scholarships have started investigating the governance of CE innovation processes (Albats et al., 2020; Patala et al., 2022). This scholarship presents CE as an agenda and principles to foster disruptive innovation and organizational change (Alexander et al., 2023; Ofterdinger et al., 2021). CE is also presented as a field informed by an interdisciplinary 'library' of practices stemming from different knowledge domains, including cradle-to-cradle (C2C) product design, systems thinking, complexity science, industrial ecology,

biomimicry, and performance economy, amongst others (Borrello et al., 2020; Hermann et al., 2022; Kirchherr et al., 2017). Moreover, research suggests that implementing CE innovation strategies impacts how skills, competencies and knowledge are (co-)created, exchanged, integrated, and shared within and between organizations.

There are three characteristics of knowledge processes used in CE innovation processes: (1) permeated by trial-and-error-based learning – a 'learning by doing' approach (Jensen et al., 2007; Provin et al., 2021); (2) cross-functional and cross-sectoral (Guzzo et al., 2023; Patala et al., 2022; von Krogh et al., 2001); and (3) relying on inter- or trans-disciplinary knowledge input for innovation (Borrello et al., 2020; Hermann et al., 2022; Morsetto, 2020). None of these characteristics are, on their own, unique to the circular innovation process. However, the degree to which they matter to CE innovation compared to other innovation activities and the combination/co-existence of characteristics, make knowledge governance issues much more complex. This suggests that firms need an internal organization that allows them to redesign innovation processes suitable for the reconfiguration of assets, resources, know-how and capabilities stemming from different knowledge and practice domains and at different levels or scales (Burger et al., 2019; Esposito et al., 2018; Fischer et al., 2022). This requires specific considerations and demands scholarly attention on knowledge governance mechanisms (Albats et al., 2020; Dzhengiz et al., 2023).

Although CE studies in innovation management literature have gained traction, most studies are focused on deriving solutions based on CE principles, redesigning business models and developing the skills needed for CE (Bocken et al., 2016; Burger et al., 2019; Esposito et al., 2018; Fernandez de Arroyabe et al., 2021; Rose & Bharadwaj, 2023). These studies often assume that firms have the structure, mechanisms, capabilities, and knowledge to implement these solutions. In practice, however, firms need more guidance in organizing their innovation activities to implement these CE solutions (Patala et al., 2022; Suchek et al., 2021). Hence, this lack of attention given to the internal organization of knowledge processes and governance considerations associated with adopting CE innovation processes in firms is problematic.

This conceptual paper aims to tackle this issue by examining the adoption of CE principles in firms' innovation processes from a microfoundations, knowledge governance perspective. Specifically, we conceptualize firms' transition into CE innovation processes by explicating the underlying governance mechanisms and relationships. Drawing upon the knowledge governance concept (Foss et al., 2010; Michailova & Foss, 2009), we focus on *how structure and organizational mechanisms influence knowledge processes within the firm that facilitated the adoption of CE principles in the firm's innovation processes*. Organizational processes such as using, sharing, integrating, and creating knowledge are related to organizational change and innovation (Grandori, 2016; Grandori & Kogut, 2002). In addition, we also focus on the agency in knowledge governance mechanisms that ultimately reside in individuals making decisions, which include acting and enacting practices in teams and organizations (Foss et al., 2010). Understanding the micro level (i.e., organizational members) and their interactions may yield novel insights into firm-level phenomena.

We contribute to the CE innovation management literature in two ways. First, we link the adoption of the CE innovation process to knowledge governance and the underlying knowledge processes. We theorize how the characteristics of CE principles and associated innovation processes pose unique, multilevel governance challenges to firms. In CE, knowledge governance is an emerging, important conversation in current management and innovation literature (see Patala et al., 2022). This emergence stems from the need for firms to redesign the internal organization to enable the adoption of CE principles in their innovation processes (Guzzo et al., 2023; Suchek et al., 2021; von Krogh et al., 2001). Moreover, understanding the influence of knowledge governance on

knowledge processes allows practitioners to design mechanisms that facilitate the usage, sharing, integration and creation of knowledge around the implementation of CE principles.

Second, this paper contributes to the current efforts by researchers to apply a microfoundational lens when examining innovation phenomena (e.g. Fernandes et al., 2023; Reynolds et al., 2024). We highlight the microfoundations nuances of circular innovation process adoption pertinent to organizing innovation activities within the firm. Current CE literature in management and innovation is heavily focused on piecemeal solutions with minimal attention to the influence of agency within the firm (see Dzhengiz et al., 2023; Suchek et al., 2021). For instance, CE-related business model innovation often requires systemic organizational change contingent on buy-ins from various internal and external stakeholders (Fernandez de Arroyabe et al., 2021; Linder & Williander, 2017). Hence, this paper provides a first step towards incorporating agency into innovation studies examining the development of CE-inspired innovation processes and outcomes. The multilevel approach in this paper also provides a more holistic view of organizing these innovation activities and showing the interconnectedness of these different actors and mechanisms within the firm.

The remaining of this paper is organized as such. First, we introduce the knowledge governance concept because we use it to analyze the adoption of circular economy processes in firms. Next, we present the microfoundations approach as the organizing framework to organize our analysis of circular economy adoption. A literature review on CE and innovation processes follows this. We then present the knowledge governance mechanisms based on our conceptual analysis of the CE literature, followed by a discussion of our conceptual analysis and the presentation of our microfoundations knowledge governance framework. This paper ends with a conclusion outlining the theoretical contributions and practical implications.

2 The Knowledge Governance Concept

We follow explanatory, narrative-style theorizing to address and explain the governance issues related to adopting CE innovation processes (Cornelissen, 2017). We draw upon the knowledge governance concept as the foundational perspective to answer our research question (Jaakkola, 2020). The knowledge-based view posits that knowledge is vital to a firm's innovation process. A firm's ability to create innovative outcomes stems from its knowledge and the recombination of the knowledge in novel ways (Grant, 1996; Spender, 1996; von Krogh et al., 2001). However, firms often search for and use external knowledge in their innovation processes (Woodfield et al., 2023). Hence, one could argue that firms innovate by recombining their knowledge with those outside the firm. Given this assumption, considerable efforts are expended on coordinating knowledge processes (Grant & Baden-Fuller, 2004; Kogut & Zander, 1996; Teece, 2000). When these efforts are not managed effectively, firms cannot adapt to the environmental and social changes emerging from their environment (Lavie et al., 2010).

Understanding these coordination efforts and their relations with knowledge processes requires focusing on the individuals within a firm, their heterogeneity, and interactions (Felin & Foss, 2005; Felin & Hesterly, 2007; Grant, 1996). The knowledge governance perspective suggests that organizational mechanisms can influence and direct knowledge processes (Grandori, 2001, 2016). Knowledge governance is the use of organizational structure and mechanisms to influence the knowledge processes such as knowledge use, transfer, sharing and integration (Foss et al., 2010; Michailova & Foss, 2009). In Foss et al. (2010), mechanisms are divided into formal and informal mechanisms. Formal mechanisms include organizational structure, routines and practices

that support knowledge-process coordination. Informal mechanisms such as network, culture and management styles are more intrinsic.

Studies in knowledge governance show that these mechanisms are useful in coordinating knowledge production and dissemination processes in meta-organizations (Pemsel et al., 2014), user-producer product development (Ooi & Husted, 2021), collaborative communities (Kolbjørnsrud, 2016) and addressing complex social problems (Gerritsen et al., 2013). While some studies show that these mechanisms should be combined to maximize efficiency and effectiveness, others have indicated that they could be applied as substitutes (Grandori, 2001; Michailova & Foss, 2009). Importantly, the choice of mechanisms to apply to facilitate knowledge production and dissemination within the firm depends on the individuals, knowledge characteristics and context. For instance, Foss et al. (2010) show that organizational culture is more significant in influencing knowledge sharing than pecuniary incentives. Similarly, Ooi and Husted (2021) posit that product development teams leverage user knowledge even without formal incentives. Instead, these teams are motivated to do so by the mantra of the firms they work in, which emphasizes the importance of engaging users in new product development.

Using knowledge governance's fundamental assumption that structure and mechanisms influence and direct a firm's internal coordination of knowledge processes, we theorize about the synergistic effects of knowledge flows related to CE adoption within an organization. The central tenet of knowledge governance posits that mechanisms must be adjusted to fit not only the particular knowledge-related objectives but also the context in which the organization operates (Pemsel et al., 2014); that context includes, among other things, its culture, norms, and environment (Husted et al., 2012; Kolbjørnsrud, 2016; Ooi & Husted, 2021). Based on this tenet, we argue that knowledge governance mechanisms form specific configurations required to enhance learning processes and thus contribute to developing the knowledge and capabilities needed to apply CE principles within the organization.

Moreover, knowledge governance's focus on theorizing organizational mechanisms at the micro- and meta-level is valuable and a departure from the studies that look at business model innovation as the antidote to firms wanting to adopt CE principles in their innovation process. Furthermore, as knowledge is a crucial element of complex phenomena, which includes innovation (Deichmann et al., 2021; Gerritsen et al., 2013; Grandori, 2016; Michailova & Foss, 2009), the knowledge governance lens provides us with the tools needed to develop a microfoundations framework of the adoption of CE principles in firms' innovation processes from a knowledge governance perspective. Essentially, the knowledge governance perspective helps to recognize the relation between knowledge and innovation as a distinct and strategic issue in management and organization, particularly when innovation and organizational change are concerned (Grandori & Kogut, 2002; Husted et al., 2012; Woodfield et al., 2023).

3 Organizing Framework – Microfoundations Approach

We used a microfoundations approach as the guiding framework to organize our theorizing efforts. Intentionally, we operationalized microfoundations primarily as a framework to explain the cause and effect that mechanisms have in shaping conditions and actions at different levels of our theorization (Cowen et al., 2022; Haack et al., 2019; Hedström & Swedberg, 1998). This operationalization of microfoundations allowed us to identify different levels and their knowledge governance mechanisms associated with CE-oriented innovation practices.

The mechanisms approach to applying microfoundations is widely used in organization studies and strategic management to explain multilevel social phenomena (Felin et al., 2015; Foss &

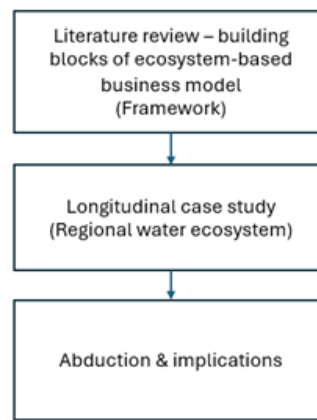


Figure 1. Summary of the research design

Pedersen, 2016; Haack et al., 2019; Kouamé & Langley, 2018). This approach focuses on explicating the constructs of social phenomena at various levels and the mechanisms and processes affecting them. Specifically, a microfoundations approach explains how macro-level constructs affect lower-level ones (i.e., meso and micro) and vice versa (Coleman, 1990; Hedström & Swedberg, 1998). Causal mechanisms and meso-level constructs link these macro and micro constructs. Interactions between causal mechanisms and meso-level constructs inform macro-micro linkages (Barney & Felin, 2013; Kim et al., 2016). We define the macro level as the firm, while the micro level means the individuals or teams.

In this paper, we started by using the generic microfoundations model presented in Figure 1 and adopted the so-called 'bathtub' model of Coleman (1990) and Felin et al. (2015). In this approach, situational mechanisms (i.e., 1 in the figure) link macro to lower-level motivational constructs. An action-formation mechanism (i.e., 2 in the figure) links lower-level motivational and action constructs. Finally, a transformational mechanism (i.e., 3 in the figure) is an emergent process linking lower-level and macro-level actions. Following the work of researchers studying and applying microfoundations (e.g. Hedström & Swedberg, 1998; Kim et al., 2016; Reynolds et al., 2024), we define these mechanisms as such:

- *Situational mechanism*: explanations of the (causal) effects that macro-level structure and events have on individual beliefs, desires, and opportunities.
- *Action-formation mechanism*: explanations of how individual beliefs, desires and opportunities lead to action.
- *Transformational mechanism*: explanations of how individual actions are converted and reconstructed as collective action(s) at the macro level.

We recognized that when engaging with circular principles to inform innovation strategies in organizations, scholars and practitioners narrate, make sense of, and identify these processes as inherently multilevel (Dzhengiz et al., 2023; Patala et al., 2022). In this perspective, CE innovation processes consist of actors, networks, capabilities, processes and mechanisms that operate at different levels and interact in unique ways to enable organizations to achieve strategic and sustainability objectives (Burger et al., 2019; Esposito et al., 2018; Hermann et al., 2022). Hence, a closer examination of the role of knowledge governance and adoption of CE innovation processes in organizations using a microfoundations lens was considered helpful in explaining

the nuances of multilevel innovation phenomena (Fernandes et al., 2023; Reynolds et al., 2024). Notably, we examine *how structure and organizational mechanisms influence knowledge processes within the firm that facilitated the adoption of CE principles in the firm's innovation processes.*

4 Circular Economy and the Innovation Process

CE revolves around the idea of changing the 'take-make-dispose' economy, also defined as the 'linear economy', evoking a sense of change and transformation at multiple levels and scales, from products to processes, from organizations to institutions (Borrello et al., 2020; Hermann et al., 2022; Kirchherr et al., 2017; Murray et al., 2017). CE offers a rationale and an agenda to strategize innovation and organizational change processes through systems thinking and by mimicking ecological relations (De Angelis & Ianulardo, 2024; Guzzo et al., 2021; Narvanen et al., 2021; Pascucci et al., 2023). This strategy is often translated into principles and practices rather than a formalized agenda, considering that a worldwide accepted definition of CE does not exist yet (Corvellec et al., 2022; Dzhengiz et al., 2023; Kirchherr et al., 2017). Despite the lack of an accepted CE definition in the literature, recent studies have begun to establish the positive effects of CE on eliminating waste, mitigating environmental degradation and firm performance (Duran-Romero et al., 2020; Esposito et al., 2024; Kunz et al., 2018; Murray et al., 2017; Suchek et al., 2021). If we focus on its 3R principles of reduce, reuse and recycle (Kirchherr et al., 2017), CE impacts innovation strategies and processes in at least three aspects:

- By invoking the *careful selection of sources of materials and energy*, thus triggering a process of change in the way firms organize their sourcing strategically and a pathway to design new products and processes using 'eco-effective' materials and renewable energy (Esposito et al., 2018; Kirchherr et al., 2017).
- By invoking a *prolonged life cycle of materials and products*, CE triggers a process of change at the design, business model and supply chain levels simultaneously (Bocken et al., 2016; Rose & Bharadwaj, 2023). Both industrial ecology and C2C design see materials and products circulating in closed loops and carefully designed metabolisms where reverse logistics and take-back systems facilitate their re-utilization and upcycling. Designing for durability, modularity, and longevity are the key dimensions of this strategic approach to life-cycle extension (Kirchherr et al., 2017).
- By invoking the *elimination of waste, pollution, and more in general negative externalities*, CE demands an agenda for (re-)valuing economic activities and resources and for aligning the regeneration of nature with social and ecological goals and needs for humanity (Albats et al., 2020; Fernandez de Arroyabe et al., 2021; Kirchherr et al., 2017; Provin et al., 2021).

These aspects are grounded in the systems perspective. When implemented by firms, they manifest in two main, related forms. First, the **collaborative form** is where the transformation of the economy is enabled by innovations led by firms and inter-firm collaborations within product development systems (Guzzo et al., 2021; Hermann et al., 2022; Rose & Bharadwaj, 2023). These collaborations put systems thinking at the core of circular principles and an integral part of any circular innovation strategy. This is particularly evident when firms co-design products based on the 3R principles and the related industry standards, which allows for eco-effective product and material cycles (Braungart et al., 2007; Provin et al., 2021). When following these principles and standards (e.g. certification criteria), firms redefine innovation processes, leading to

the reconfiguration of their resources, competencies and, ultimately, boundaries (Fernandez de Arroyabe et al., 2021; Guzzo et al., 2021; Ofterdinger et al., 2021).

Second, in the **business model reconfiguration form**, firms interested in circular innovation processes tend to change their business model by reconfiguring their supply chain and marketing relations, including key partners, customers and related resources and competencies. Depending on firms' objectives when implementing CE, they often experiment with new configurations of their business model activities, such as logistics, customer-service interface and marketing relations, contract and legal devices, and risk management tools (Dragan et al., 2024; Fischer et al., 2022; Provin et al., 2021). The more a company engages with reconfiguring the activities in its business models, the more disruptive its circular innovation strategy can become, including changing processes, technologies, customers, and partners' beliefs and behaviors (Esposito et al., 2024; Frishammar & Parida, 2019; Guzzo et al., 2021; Kunz et al., 2018; Ofterdinger et al., 2021).

The collaborative and business model reconfiguration forms that CE innovation strategy manifests in firms are centered on a critical ingredient – knowledge. Whether a firm decides to implement a CE innovation strategy through establishing collaboration with different partners or reconfiguring its business model activities, knowledge plays a vital role in facilitating and sustaining these initiatives (Frishammar & Parida, 2019; Hermann et al., 2022; Rose & Bharadwaj, 2023). Particularly, the governance of knowledge flows allows firms to search, transfer, share and integrate knowledge about CE innovation processes into firm-level outcomes (Dragan et al., 2024; Dzhengiz et al., 2023; Esposito et al., 2018). Notably, these collaborative arrangements and business model reconfiguration also require internal organizational changes through engaging stakeholders internal and external to the firm (Albats et al., 2020; Dragan et al., 2024; Hopkinson et al., 2018). These changes relate to the coordination of the (co-)creation, sharing and use of knowledge beyond the firm and define supply chain-wide collaboration, for example, to manage resource ownership and related uncertainties beyond the firm's boundaries (Patala et al., 2022; Suchek et al., 2021). Ultimately, all these changes in business activities require firms to adopt governance mechanisms to manage these knowledge flows and processes (Fischer et al., 2022; Ofterdinger et al., 2021). This poses a question of how knowledge governance is mobilized to influence the adoption of CE innovation processes.

5 Emergence of Knowledge Governance Mechanisms in Circular Economy

Our approach started with an *a priori* knowledge governance lens and microfoundations logic to theorize about CE innovation process adoption in firms. We illustrate our conceptual arguments with specific cases in the literature that explore organizational change and circular business model innovation. These cases were used for illustrative purposes only. They do not form part of our theorizing efforts. These cases were selected based on the criteria that a) the organizations adopted CE principles and practices in their operations, b) the example was informative and explicitly narrated the role of knowledge flows in the organization adoption process, including reference to skills, capabilities, and competencies.

Our theorization efforts of the CE literature using a microfoundations organizing framework have brought to light the presence of two distinct patterns of interaction between macro-level constructs and micro-level knowledge processes influencing the adoption of CE innovation processes. Namely, the presence of (i) a pattern of reconfiguration of knowledge flows and competencies within the boundaries of the firm (Theme A – Figure 2); (ii) a pattern of experimentation with novel (to the firm) knowledge flows and the reconfiguration of the firm's boundaries (Theme B – Figure 3). We first present these two patterns, related macro-level constructs, and associated knowledge processes, looking particularly at mechanisms that influence and direct the firm's internal coordination of knowledge. We then reflect on their commonalities and draw a more general model on the role of governance of knowledge flows in CE innovation processes.

5.1 Reconfiguration of Knowledge Flows and Competencies Within Firm Boundaries

Starting from what we define as process-oriented mechanisms of reconfiguration of existing knowledge flows (Theme A), we recognize that the context leading firms to engage with CE innovation processes comes with the opportunity and need to consider a new product development (NPD) strategy. By designing (a set of) new products or redesigning existing ones, firms embrace CE innovation processes in developing an eco-friendly strategy coupled with a customer and user-oriented, marketing-led approach. The mechanisms emerging in these conditions can be categorized as exposure to product design thinking and the application of eco-design principles related to an NPD strategy, which manifest in three main mechanisms:

- *Situational mechanism* (top-down), the firm's lead management instilled the need to engage in an eco-friendly new product development (NPD) project, which mobilizes internal competencies and knowledge flows on circular and C2C/eco-effective design principles from (a team of) designers operating in the firm.
- *Action-formation mechanism* (a team of) designers inspired by processes of co-creation and sharing with other CE or C2C experts and 'absorbing' external knowledge by setting up an NPD project.
- *Transformational mechanism* (bottom-up) (team of) designers operating in the firm stimulating a process of 'discovery' and experimentation to address an NPD challenge and 'adapt' circular and C2C/eco-effective design principles based on their expertise and know-how.

Despite the nuances, these knowledge governance mechanisms indicate that CE innovation processes come into play in a context where an NPD challenge is key to the firm. To illustrate, when reporting the W&M product design innovation example, Hansen and Schmitt (2021) thoroughly analyzed how a firm overcomes barriers to adopting a C2C-designed product to operationalize CE and related situational mechanisms. In this example, W&M's 'push' for engaging and subsequently adopting C2C principles started when the head of product development was inspired by reading about C2C and the subsequent engagement with the C2C certification body. A similar effect has been observed for several other firms that engaged with product design challenges inspired by C2C, such as DESSO, one of the earlier adopters of C2C and eco-effective design principles for their products (Wallace, 2015). Linder and Williander (2017) report on the example of Unicykel and how the firm engaged in the process of design for remanufacturing when looking at a new business proposition connected to electric bikes. In this example, Unicykel applied the principles of material health and servitization to modules of an electric bike offered to customers through a subscription

Table 1. Key academic sources used for illustration.

Selected case/literature/report	Description	Relevance for theorizing/conceptualization	Key knowledge governance aspects
Guldman, E., & Huulgaard, R. D. (2020). Barriers to circular business model innovation: A multiple-case study. <i>Journal of Cleaner Production</i> , 243, 118160.	Multiple business cases of circular business model innovation (CBMI) in several sectors involving start-ups and incumbent firms	Focus on barriers to adoption and diffusion of CE principles and practices in start-ups and incumbent firms.	Focus on the role of competence and skill development to overcome barriers to innovation related to the inter-sectoral and interdisciplinary nature of CE.
Hansen, E. G., & Schmitt, J. C. (2021). Orchestrating cradle-to-cradle innovation across the value chain: Overcoming barriers through innovation communities, collaboration mechanisms, and intermediation. <i>Journal of Industrial Ecology</i> , 25(3), 627-647.	The study will examine barriers to business model innovation related to a value chain and collaborative project in the chemical industry and the link to a C2C-inspired product redesign project.	Focus on how C2C product design principles can trigger organizational change at the inter-firm level (value chain) and how collaboration is key in CE innovation.	Relevance of inter-firm collaborations in C2C design projects and how internal and external knowledge flows can be combined.
Patala, S., Albareda, L., & Halme, M. (2022). Polycentric governance of privately owned resources in circular economy systems. <i>Journal of Management Studies</i> , 59(6), 1563-1596.	Investigation of industrial parks and cross-sectoral partnerships to support CE-oriented innovation processes and industrial symbioses.	Focus on polycentricity and governance relevant to (co-)ownership of resources and co-innovation.	Highlighting the relevance of cross-sectoral resources and know-how, including reconfiguration of knowledge flows combined with materials flows.
Linder, M., & Willander, M. (2017). Circular business model innovation: inherent uncertainties. <i>Business strategy and the environment</i> , 26(2), 182-196.	Case of business model innovation in an agile SME led by a CE-inspired product redesign project.	Focus on how product redesign can trigger organizational change and inter-firm collaborations when firms are focused on CE principles.	Relevance of internal and external knowledge flows, competence, and skills development.
Guzzo, D., Mascarenhas, J., & Alexander, A. (2023). 10 The transformational power of Circular Innovation. <i>Handbook of the Circular Economy: Transitions and Transformation</i> , Alexander, A., Pascucci, S., & Charney, F. (Eds.). (2023). Walter de Gruyter GmbH & Co KG.	Conceptual and analytical overview of circular innovation strategies and reference to several industries and business cases.	Focus on the relationship between CE and innovation strategies.	Focus on how competence building, and knowledge recombination inform CE innovation strategies.

Table 1. Key academic sources used for illustration (continued).

Selected case/literature/report	Description	Relevance for theorizing/conceptualization	Key knowledge governance aspects
Fischer, A., & Pascucci, S. (2017). Institutional incentives in circular economy transition: The case of material use in the Dutch textile industry. <i>Journal of Cleaner Production</i> , 155, 17-32.	Conceptual analysis of organizational and institutional change inspired by CE at different scales and levels in the Dutch textile sector.	Focus on institutional mechanisms and organizational change related to CE principles and practices.	Highlighting the relationship between governance and organizational change at various levels and scales includes reconfiguring knowledge and competencies.
Bocken, N., & Ritala, P. (2021). Six ways to build circular business models. <i>Journal of Business Strategy</i> , 43(3), 184-192.	Conceptual and analytical overview of the relationship between circular business model and innovation strategies.	Focus on innovation strategies as ways of reconfiguring business models in firms when inspired by CE.	The relevance of firm's capabilities and governance at firm and inter-firm level.
Bocken, N. M., Schuit, C. S., & Kraaijenhagen, C. (2018). Experimenting with a circular business model: Lessons from eight cases. <i>Environmental innovation and societal transitions</i> , 28, 79-95.	Conceptual and analytical overview of experimentation cycles in circular business innovation strategies.	Focus on experimentation and innovation pathways in different business model settings.	Investigate the relevance of new skills, competencies, and capabilities to developing CE innovations.
Ritala, P., Bocken, N. M., & Konietzko, J. (2023). 11 Three lenses on circular business model innovation. <i>Handbook of the Circular Economy: Transitions and Transformation</i> , Alexander, A., Pascucci, S., & Charney, F. (Eds.). (2023). Walter de Gruyter GmbH & Co KG.	A conceptual overview of circular business model innovation as a product, process, and organizational change strategy.	Focus on the relationship between CE innovation, innovation management and organizational change.	Discussion on the role of strategic competencies in firms interested in CBMI and focused on CE innovation strategies.
Blackburn, O., Ritala, P., & Keränen, J. (2023). Digital platforms for the circular economy: Exploring meta-organizational orchestration mechanisms. <i>Organization & Environment</i> , 36(2), 253-281.	Discussing digital platforms and inter-firm collaboration to enable CE innovation strategies.	Focus on digitalization and governance mechanisms in the context of collaborative platforms.	Discuss how skills and competencies revolve around digitalization and enabling factors for CE-inspired business transformation.

fee-based model, thus leading the company to adopt a product-as-a-service (PaaS) innovation strategy. The owners of Unicykel initiated the project and involved reconfiguring its knowledge flows between team members to enable the integration of knowledge and expertise that typically would have been siloed. This included, for example, designing and optimizing the life cycles of modules (e.g., battery, chain, main structure) that relied on involvement by both the engineers and in-house financial specialists to ensure that the 'take back' of modules would be aligned with acceptable levels of financial risks. Design for durability and modularity entails a prolonged technical and financial life-cycle of materials, components and products, posing challenges in aligning design principles with financial incentives in circular business models (Fischer et al., 2022).

In all these examples, the eco-friendly design principles function as a means-to-an-end for the firms' teams of experts and designers but do not necessarily reflect the original purpose of the particular NPD challenge. The result is the establishment of a product design project led by a team within an existing company or as a start-up or spin-out, particularly if the NPD design challenges relate to a brand-new product (point B in Figure 2). The established NPD project also enables knowledge creation and sharing processes at the individual level within the organization embedded in a CE-focused action-formation mechanism. As an outcome, firms grow their internal competencies and organizational capabilities to experiment with and operationalize CE innovation processes and C2C design principles. Fundamentally, this approach to governing knowledge processes, on the one hand, utilizes similar stages and processes common to any product innovation processes, such as testing of competing designs, prototyping, and, eventually, product launch. However, on the other hand, since circular and C2C principles demand a greater focus on material health, re-utilization, renewable energy, and social responsibility, a new type of knowledge-based interaction emerges between the (team of) designers and the other departments or experts/leaders in the firm which is not commonly associated with standard NPD processes.

This is evident by looking at the example of C2C-certified products reported by the Cradle-to-Cradle Product Innovation Institute (<https://c2ccertified.org/>). The institute has set up a library reporting examples of firms engaged with the certification process in redesigning their products. The examples all indicate that the interdisciplinary and cross-sectoral nature of C2C led to knowledge flows engaging expertise from different disciplines and cross-sectoral capabilities. This leads to additional impact when the project team and experts emerge into a broader (knowledge) platform, where CE skills and competencies inform other processes, and vice-versa, benefit from other skills and competencies. The related transformational mechanism shapes the launching of a new product 'embedded' in a novel circular business model, aligned with the existing firm's business model, or constituting a brand-new circular business model in the context of a start-up or spin-off company.

Regardless, the CE innovation processes strategy works to align the design principles applied at the product level to the business model architecture and how to create, deliver and capture the value of a circular/C2C design product. Our findings indicate that different circular business models can emerge, particularly product-as-a-service (PaaS) models, where companies use servitization (lease or hire models) to enhance asset productivity or product-from-waste (PFW) models, where companies up-cycle waste material flows into higher value products and materials, or circular design models, where companies optimize the design of products or materials for enabling recycling, refurbishing, remanufacturing, maintenance and reuse or restoration (Alexander et al., 2023).

In all these models, the role of final users is critical to shaping the design for the new circular economy product and determining the configuration of the associated business model. This opens opportunities for knowledge sharing and co-creation with final users, as well as circular business model innovation trajectories in which users are incentivized to remain engaged in a continuous

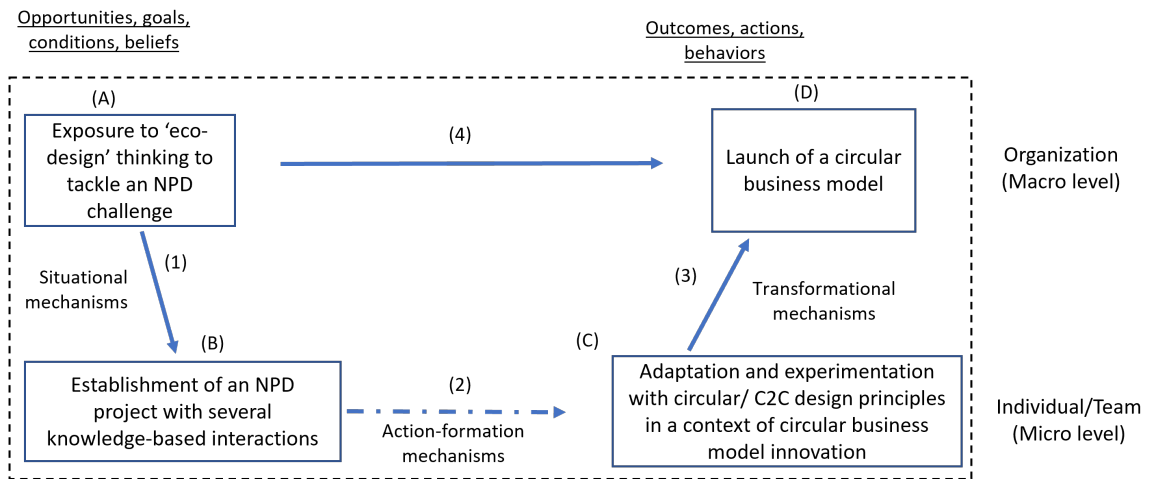


Figure 2. Reconfiguration of knowledge flows and competencies within the firm boundaries (Theme A)

optimization process, leading to improvement of both the product design and business model over the cycles of usage/recycling or upcycling of the product(s) or material(s). The outcome of this mechanism (point D in Figure 2) is the establishment and consolidation of a new circular business model within the pre-existing business model of the company or the scaling of the business model and the development of new circular products with the transformation of the pre-existing firm's business model into a circular one.

Table 2. Reconfiguring knowledge flows and competencies within the firm boundaries (Theme A).

Strategic context justifying the engagement with CE innovation processes	Description of the CE innovation processes	Organizational knowledge governance conditions (A)	Situational mechanisms (1)	Individual/team knowledge governance conditions (B)	Action-formation mechanisms (2)	Individual/team knowledge governance behaviors (C)	Transformational mechanisms (3)	Organizational outcome (4)
Firm interested in expanding its product portfolio and/or enhancing environmental performances/reducing negative footprint (Wallace, 2015) Firms (often start-ups or SMEs) interested in exploring new product development (NPD) challenges and identifying eco-friendly design principles (e.g., C2C) as a means-to-an-end approach to address the NPD challenge (Linder and Willander, 2017)	New (set of) products or processes are (re-)defined in an established firm because of the CE innovation strategy (Hansen and Schmitt, 2021) Introduction of a new business venturing process such that the NPD is coupled with the establishment of a new firm/company (Guldmann and Huuligaard, 2020; Linder and Willander, 2017)	Existing internal expertise exposed/interested in eco-design principles (Hansen and Schmitt, 2021) Consolidated team-based R&D conditions prone to new product development (NPD) and product (re-)design thinking (Linder and Willander, 2017) Customer-oriented innovation / diffused customization capabilities/expertise (Linder and Willander, 2017) Reliable and long-standing relationships with networks of partners/customers (Fischer et al., 2022)	Flexible and adaptable teamwork generating problem-solving and design thinking attitudes and motivations (Linder and Willander, 2017) Customer/user relations inform design thinking within the firm (Guzzo et al., 2023)	Establishment of a product design project led by a team within an existing company or as a start-up or spin-out, particularly if the NPD design challenges relate to a brand-new product (Linder and Willander, 2017)	Employees and teams quickly adapting to CE/C2C design thinking stimulate the definition of new propositions for material health, reutilization, enhanced product longevity and modularity (Alexander et al., 2023; Hansen and Schmitt, 2021)	Team members adopt and adapt design thinking practices for re-manufacturing, repair, and upcycling (Alexander et al., 2023) Assessing customer relation scenarios (Guzzo et al., 2023) Designing and manufacturing of product components (Hansen and Schmitt, 2021) Redefinition of (financial) risk assessments (Guzzo et al., 2023)	Experimentation with modularity and longevity design principles and practices lead to a circular business model (Guldmann and Huuligaard, 2020) Launch of new products 'embedded' in a novel circular business model, aligned with the existing firm's business model, or constituting a brand-new circular business model in case of a start-up or spin-off company (Alexander et al., 2023; Bocken and Ritala, 2021; Linder and Willander, 2017)	Definition and establishment of a new circular business model (Alexander et al., 2023; Bocken and Ritala, 2021) Monitoring of the performance of the design and the CBM (Fischer and Pascucci, 2017) The decision to scale (or not) the CBM (Linder and Willander, 2017)

5.2 Experimenting with Novel Knowledge Flows and Competencies to Redefine Firm Boundaries

A second pattern of microfoundations mechanism is strategic-oriented. It relates to what we consider experimentation with novel (to the firm) knowledge flows, resulting in reconfiguring the firm's boundaries (Theme B – Figure 3). This pattern seems more likely to emerge when, in particular, multinational corporations are concerned about their sourcing strategies, need to optimize their materials flow management and reduce their (negative) footprint on environmental resources and local communities (Fischer & Pascucci, 2017). In this context, firms' strategists are looking for 'alternative scenarios' to challenge their current business models but within a 'solution-oriented' trajectory. Often, this is a context where firms are already in the process of reconfiguring their business models more substantially and are exposed to the risks and uncertainties due to so-called grand challenges, from climate change to biodiversity loss, from food security to soil health problems (Whiteman et al., 2013). In this context, high-level skills, competencies, and organizational capabilities are mobilized to experiment with and identify solutions and scenarios for the given challenges. The mechanisms emerging in these conditions can be categorized as exposure to a set of socio-ecological challenges that have the potential to impact the company's strategy, requiring deeper considerations at both short- and long-term levels. These conditions manifest in three main microfoundations mechanisms:

- *Situational mechanism* (top-down), firm's lead strategist(s) or leaders (e.g., CEOs, Board of Directors) identify the need to engage with emerging and compelling socio-ecological challenges, including climate change, societal demands for eco-friendly products, reputational and financial risks on long term accessibility to resources. These 'high-level' concerns push the mobilization of internal teams, looking for strategic competencies and knowledge flows, and looking at developing CE-related skills and expertise as a means-to-an-end to tackle the challenges.
- *Action-formation mechanism* (a team of) strategists and leaders in the firm are embedded in wider inter-firm collaborations that push to redefine the boundaries of the firm competencies and knowledge flows, thus provoking a deeper reconfiguration of the business model towards CE (organizational) innovations.
- *Transformational mechanism* (bottom-up) (team of) strategists operating in different departments are pushed to co-create, use, share, and exchange CE-related skills and expertise both internally and externally, often moving into a pre-competitive and value chain level of collaborations.

An example of such a context is IKEA's 'take back' system, one of the leading companies in the global furniture industry. The take-back program (<https://www.ikea.com/gb/en/customer-service/services/buy-back/>) is a standard 'end of the pipe' solution that supports refurbishing and the reduction of waste of valuable materials and products while incentivizing customers to buy new furniture. This approach allowed IKEA to tackle pressures related to its wasteful business model and environmental footprint by introducing and adapting to circular business practices while offering a new service concept to its customers and finding incentives to repair and adapt products to extend the product life-cycles (Malmgren & Larsson, 2020). The take-back system introduced by IKEA is a first step towards more disruptive practices, where products can be designed for reparability and longevity, thus allowing for upcycling components and materials when returned

to the company, as well as supporting product-as-a-service approaches, thus introducing further incentives for both customers and the company. Take-back systems demand reconfiguration of logistics capabilities, combined with customer-support services and IT capabilities. Moreover, introducing a reverse logistics strategy to support the take-back opened the window of further change at the supply chain level, thus connecting take-back systems with design and sourcing. This results in the potential to further disrupt the firm's business model and transition into a wider circular one (Szerakowski, 2017).

Take-back systems of this type are usually the most used strategies for large corporations to start engaging with grand challenges by introducing and adopting circular principles without challenging too many existing business models. This creates a context for experimenting with practices that address the need to respond to increased socio-ecological challenges in terms of reputation and corporate social responsibility, particularly in strategic operations, including sourcing. In this context, strategists mobilize multiple teams internally and bring in external knowledge from other experts or organizations (e.g., SMEs or start-ups), often establishing small-scale strategic projects (point B in Figure 3).

Therefore, the knowledge governance approach differs from what we have described in the previous pattern because it is anchored to macro-level strategic processes from the beginning. This pattern is not limited to product design principles, such as C2C or eco-effective design. Instead, it engages with systems thinking and the adaptive capabilities of the firm in the context of networking and collaboration with other firms. The CE 100 network (CE 100) set up by the Ellen MacArthur Foundation (EMF) provides an example of how this mechanism has been adopted by several large corporations in different global industries and as a response to grand challenges (<https://ellenmacarthurfoundation.org/network/who-is-in-the-network>). This is typically a pattern in which a leading firm mobilizes its supply chain partners to tackle a strategic problem, where several companies are engaged in a pre-competitive challenge, and where several small-medium enterprises (SMEs) engage collectively to define new strategies (Fischer & Pascucci, 2017). In establishing these collaborative projects, firms are interested in operationalizing circular principles related to industrial ecology, complex adaptive systems, biomimicry, and performance economy rather than 'just' product design. Moreover, involved firms are interested in operating at the sector, industry, or supply chain level rather than 'just' at the firm level.

The establishment of a set of (inter-firm) collaborative projects defines the context for an *action-formation mechanism*, where novel skills and competencies, for example, in terms of systems thinking and organizational adaptability, are transferred to other individuals and teams internal to the firm, and the process of a more systemic transformation begins to affect the firm more widely. In this context, circular principles and CE innovation processes are related to process and organizational innovation. This may or may not be linked to a specific product, used as a pilot to experiment, and test a broader innovation trajectory. However, by design, it intends to change a core area of the company in coordination and alignment with other organizations, sometimes including competitors. The outcome of this action-formation mechanism is the definition of (teams) of 'circular experts' internal to the company but in constant conversation with other experts, ensuring a flow of knowledge co-creating, sharing and exchange that continuously links the firm to other organizations. Think-tanks and NGOs often facilitated these processes as part of their advocacy for CE transformations. This mechanism resembles collaborative and open innovation processes, where individual and team-based skills and competencies from within and outside the firm start to 'percolate' and 'absorbed' by other individuals and teams, thus creating the conditions for a deeper and wider transformational mechanism. The result (point D in Figure 3) is the emergence of a firm-wide transformation strategy informed and influenced by CE principles

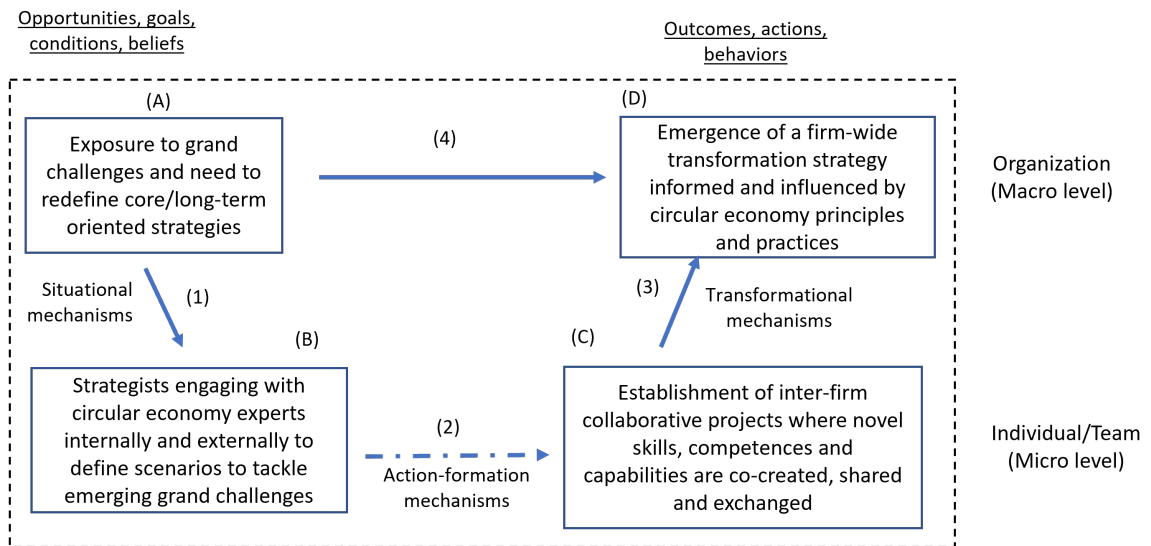


Figure 3. Experimenting with novel knowledge flows and competencies to redefine firm boundaries (Theme B)

and practices. This 'transformation pathway' includes CE innovation processes such as process, organization, and institutional innovations (Fischer et al., 2022), 'embedding' and redefining internal and external knowledge flows. Moreover, the systemic nature of the innovation strategy demands co-design with other organizations a broader innovation ecosystem, using networks and collaborative inter-firm projects as a platform to experiment with change and innovation over time (see also Offerding et al., 2021; Patala et al., 2022).

Table 3. Experimenting with novel knowledge flows and competencies to redefine firm boundaries (Theme B).

Strategic context justifying the engagement with CE innovation processes	Description of the CE innovation process	Organizational knowledge governance conditions (A)	Situational mechanisms (1)	Individual/team knowledge governance conditions (B)	Action-formation mechanisms (2)	Individual/team knowledge governance behaviors (C)	Transformational mechanisms (3)	Organizational outcome (4)
Firms respond to increased pressure by designing new products and processes aimed at social and environmental justice innovation strategies (Malmgren and Larsson, 2020; Whiteman et al., 2013)	The reconfiguration of a strategic process in the existing firm (often a large corporation) inspired by CE principles and practices (Malmgren and Larsson, 2020)	Strategists are looking for 'alternative scenarios' to challenge their current business models but within a 'solution-oriented' trajectory (Fischer and Pascucci, 2017)	Adapting capabilities to design and system thinking to set up knowledge platforms to discuss and apply CE principles (Bocken et al., 2018)	Strategists motivated to deliver new CE concepts/processes and practices. Develop platforms for fostering collaborations and learning about socio-environmental impacts, enhancing design and systems thinking (Blackburn et al., 2023)	Design and systems thinking applied to a set of practices to design for modularity, longevity and servitization of products or introduce CE innovation (Bocken et al., 2018; Fischer and Pascucci, 2017)	Establishment of inter-firm collaborations (Fischer and Pascucci, 2017) Redefinition of internal and external knowledge flows (Offerdinger et al., 2021) Development of novel skills and capabilities at inter-firm and firm level (Blackburn et al., 2023)	Support of collective design and experimentation to create a CE innovation strategy to address strategic issues and tackle socio-environmental problems through a circular business model (Ritala et al., 2023)	Definition of a legally and financially viable circular business model for the firm (Fischer and Pascucci, 2017) Process of reconfiguration and organizational transformation involving several teams and departments in the firm (Bocken et al., 2018) Assessment of the strategy and decision to scale (or not) the CBM (Ritala et al., 2023)
Firms responding to increased global pressures on sourcing and market development (Fischer and Pascucci, 2017)	Agile and motivated R&D/Strategy teams And/or champions (Ritala et al., 2023)	Establishing networks and related capabilities to engage with external know-how, including social and environmental activism in business practices and strategies (Patala et al., 2022)	Team-network orientation enhanced in dedicated projects (Bocken et al., 2018; Fischer and Pascucci, 2017)					

6 Discussion

This paper aims to conceptualize the role of knowledge governance in CE innovation strategies by seeking answers to *how structure and organizational mechanisms influence knowledge processes within the firm that facilitated the adoption of CE principles in the firm's innovation processes*. We use the micro-foundations approach to provide an analytical framework for studying how constructs at the macro level, such as strategic intent, relate to the governance of knowledge processes to create innovative CE outcomes. Illustrative examples provide anecdotal background to these knowledge governance mechanisms. Our analysis of the CE literature resulted in identifying two patterns of knowledge governance mechanisms that define how CE innovation processes are intertwined with knowledge flows. Our findings have relevant implications for further theorizing innovation processes in (organizational) contexts where firms mobilize CE principles and practices and, more generally, where knowledge flows are connected to socio-ecological challenges at various levels of organizational life. Our study aims to present a knowledge governance view of CE innovation and to conceptualize the microfoundations of CE innovation processes.

As the preceding theorization section points out, the first of the two knowledge governance mechanisms refers to what we have defined as a *reconfiguration of knowledge flows and competencies within the firm boundaries*. The premise of this group of organizational mechanisms is the need for firms to adapt existing processes to implement eco-design thinking in developing new products. The *situational mechanism* here stems from a firm's management institutionalizing explicit instructions to re-orientate the firm's new product development efforts towards an eco-friendlier design. These instructions influence the mobilization and reconfiguration of internal competencies and knowledge bases. The situation mechanism leads to the establishment of new project teams with the explicit purpose of implementing eco-design thinking, which includes CE principles, in product development.

Drawing on the reconfigured competencies and knowledge bases, team members of the new project teams use *action-formation mechanism*, which is in the form of inspired project team members (e.g., designers) co-creating and sharing knowledge about CE and C2C with other members of the firm. Interestingly, the action-formation mechanism here is intrinsic compared to the more extrinsic situational mechanism. A result of the formation of new project teams and the action-formation mechanism is the increased occurrence of the firm's experimentation and adaptation of its business model to incorporate eco-design thinking and CE principles. The *transformational mechanism* here consists of project teams integrating the shared and co-created knowledge to enable the adoption of a CE-oriented business model. Hence, this pattern of governance mechanisms provides a more nuanced explanation of the underlying issues that lead to a firm's change in business model within the context of CE (Dzhengiz et al., 2023; Frishammar & Parida, 2019). Our theorizing shows that while the situational mechanism facilitates systemic change, the intrinsic action-formation mechanism plays a major role in transforming institutionalized situational mechanism into outcomes at the individual and organizational level (Fernandez de Arroyabe et al., 2021; Linder & Williander, 2017).

The second knowledge governance mechanism involves *experimenting with novel knowledge flows and competencies to redefine firm boundaries*. This mechanism group connotes a firm's strategic orientation change, often influenced by the external environment. It suggests that when a firm needs to address the grand challenges impacting core strategic activities, such as sourcing or

marketing, this condition inadvertently pushes organizations to consider CE principles and practices as one of the solutions to address these challenges. These conditions are prone to creating a *situational mechanism* where a firm's leaders identify the need to redefine strategic purposes and actions, taking the socio-ecological challenges as a serious threat to the company, both short- and long-term. Typically, these conditions include pressures from climate change and various societal demands, translating into reputational and financial risks on accessibility to resources and markets.

Action-formation mechanisms include individual employees establishing collaborative teams and communities of practice within the firm to facilitate the identification and implementation of inter-firm collaborations with various partners and actors. The response to this is the mobilization of internal teams looking for core competences and knowledge flows, where CE-related skills and expertise are considered within a set of viable solutions. *Transformational mechanisms* often follow this initial stage, and strategists become the leading figures in co-creating, using, sharing, and exchanging CE-related skills and expertise internally and externally. These skills and competencies are often found in platforms and projects between firms, in a pre-competitive space, for example, or between value chain partners. The search for these flows of knowledge and competencies triggers an action-formation mechanism in which the firm's leaders and strategists further support more comprehensive reconfiguration and inter-firm collaborations, eventually pushing to redefine the firm's boundaries altogether. Despite these fundamental differences, in terms of microfoundations mechanisms, the two processes have also highlighted a set of shared conceptual dimensions:

- CE innovations emerge where firms respond to a challenge by reconfiguring and enlarging their knowledge bases and capabilities, often through inter-organizational collaborations. As such, firms engaged in CE innovations share the critical features of knowledge-intensive industries (Grandori, 2016; Woodfield et al., 2023).
- CE innovations intertwine with knowledge flows internal and external to the firm, which provokes a more profound and broader reconfiguration of its organizational mechanisms and boundaries (Offerdinger et al., 2021; Patala et al., 2022).
- CE innovations are often championed by the firm's experts and leaders, thus suggesting an expert-based model of the absorptive capacity of the firm when dealing with knowledge flows (Burger et al., 2019; Sjödin et al., 2019).

The knowledge governance mechanisms presented in Figure 3 provided the connotations that an extension of the framework outside the firm's boundaries is required. We theorize that firms would face intense pressure from their external environment to adopt strategic orientations and implement processes that address sustainability goals. The resulting single firm-level outcome is a strategic organizational change that facilitates inter-firm collaborations and reconfiguration of business models. Therefore, there is a need to include a value-chain or industry-level conceptualization of the microfoundations of CE innovation processes. Based on these points, we propose an overarching conceptual framework in Figure 4 that shows how knowledge governance mechanisms within the firm could be manifested outside firm boundaries.

In this framework, we recognize that increasing pressures on firms to address socio-ecological challenges represent a common set of antecedents conducive to adopting CE innovation strategies. These pressures result in focusing on solutions to address concerns related to the availability of strategic resources, emerging market demands, and reputational and financial risks. They create conditions for supporting and championing CE solutions through a new product design or strategic activity. The subsequent step (stage 2 in figure 4) is the search for internal and external expertise by identifying knowledge flows relevant to informing and supporting the CE

innovation process. This creates the supporting conditions for experimenting with innovative projects and coordinating the (co-)creation, sharing and use of knowledge within and beyond the firm's boundaries. Projects create the space where C2C designers, CE experts and strategists, team-up and create the conditions for absorbing novel competencies and know-how. Projects form knowledge platforms within and between firms, in pre-competitive settings, and at the value chain level, creating the opportunity to develop further and implement CE practices. Stage 4 of our framework results in adopting a circular business model at the project or firm level. Eventually, this process creates the conditions for a wider adoption and diffusion mechanism of CE innovations at the industry and supply chain level and beyond the firm's boundaries. This emerging conceptual framework further clarifies the knowledge processes and unpacks the role of knowledge governance mechanisms to explain how this process unfolds, especially how CE innovations manifest at different organizational levels and contexts.

7 Conclusion

Our study concludes that knowledge processes are essential when firms implement CE principles in their innovation processes and strategies. The knowledge processes associated with CE innovation represent a unique combination of characteristics, including reliance on trial-and-error-based learning, genuine cross-functional and cross-sectoral knowledge processes across the spectrum of knowledge processes, including knowledge co-creation, inter- or trans-disciplinary knowledge input and significant elements of unlearning. This unique combination/co-existence of characteristics combined with the degree to which they matter to CE innovation compared to other innovation activities makes knowledge governance issues much more complex than associated with innovation processes.

7.1 Theoretical Implications

Our conceptualization and overarching framework (Figure 4) address the call for studies examining the governance challenges of CE (Patala et al., 2022). While adopting and implementing CE solutions could be easy for some firms, most would require an adaptation and reconfiguration of their internal organization and business models. Our framework provides researchers examining CE governance issues with the starting point needed to examine microfoundational knowledge governance issues within the firm. We also provide a glimpse of how these knowledge governance issues could expand to a network or systems level (Guzzo et al., 2021; von Krogh et al., 2001). Importantly, we highlight the microfoundations and their pertinent mechanisms to explain the nuances of CE innovation process adoption within the firm to develop CE solutions (Fernandez de Arroyabe et al., 2021; Linder & Williander, 2017). Our framework implies that studying CE solutions alone cannot explain firms' success or failure in CE initiatives. Researchers need to pay more attention to the microfoundations of these CE solutions and to organizing innovation processes and activities to create these solutions in the first place (Fernandes et al., 2023; Reynolds et al., 2024).

7.2 Practical Implications

More specifically, the governance of these knowledge processes, in the form of situational, action-formation and transformational mechanisms, facilitates a firm's transition to CE innovation outcomes. Our conceptual framework has implications for firms adopting CE principles in their innovation process.

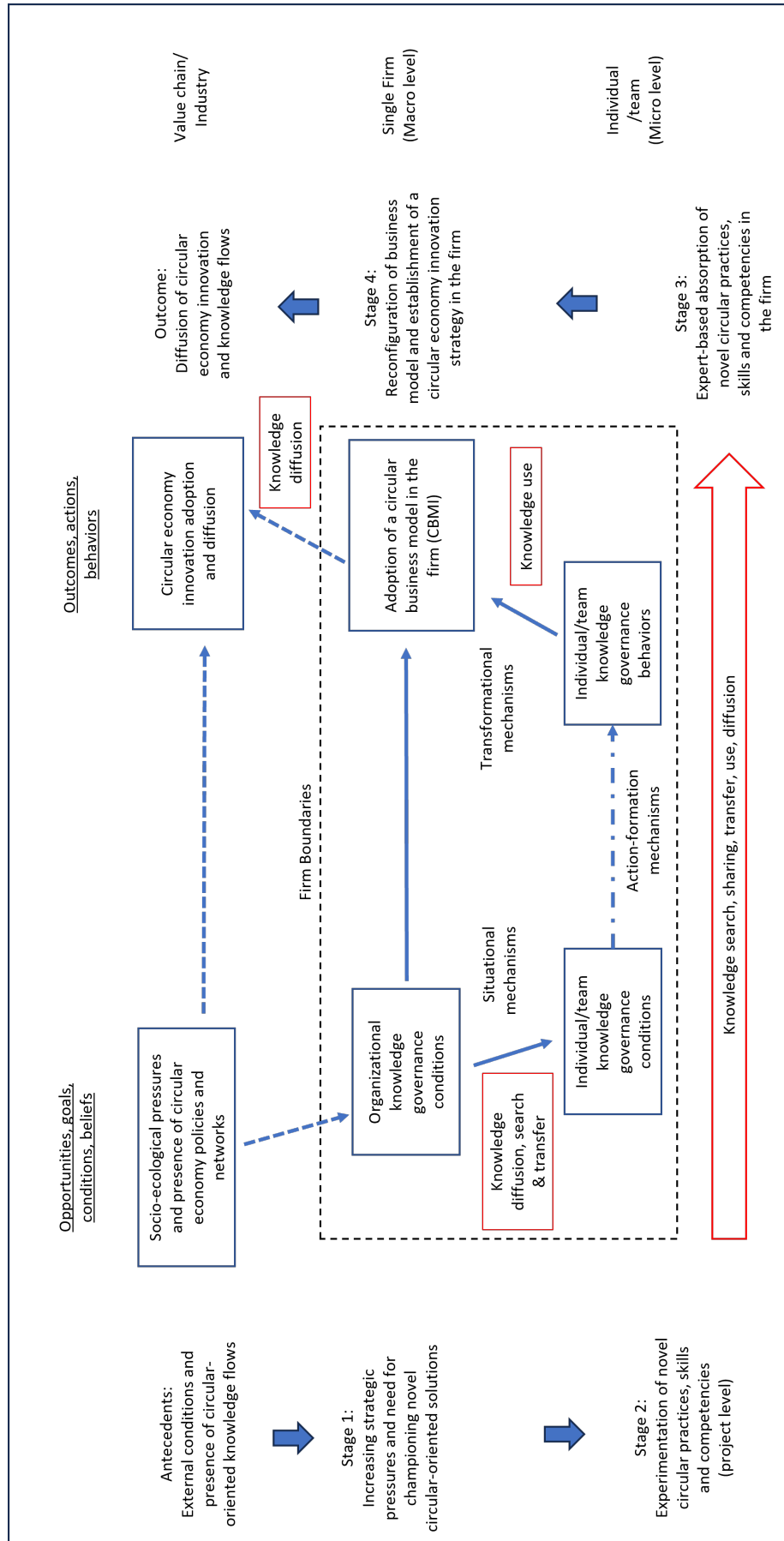


Figure 4. Microfoundations of CE innovation processes

- The innovation process for developing CE products requires firms to search for new knowledge from within and outside the firm. Firms could ensure relevant organizational mechanisms are in place that would allow them to reconfigure knowledge bases and competencies. These mechanisms must also facilitate intra- and inter-organizational knowledge search, transfer, sharing and integration.
- Firms wanting to incorporate circularity principles in their innovation processes must also change their business models. However, business model changes are systemic and require buy-ins from stakeholders, such as employees. While buy-ins could be achieved through explicit knowledge governance mechanisms, true buy-ins are often achieved when stakeholders are intrinsically motivated to share and use new knowledge related to CE.
- Governing knowledge processes within a firm is more than just a (re)design of organizational mechanisms. This simplistic view obscures the complexity often associated with adopting CE (or sustainability) principles in a firm's innovation process. Hence, firms wanting to design knowledge governance mechanisms to facilitate CE innovation processes must take a systems view. The conceptual framework presented in Figure 4 allows firms to understand the stages, antecedents, outcomes, and mechanisms pertinent to managing knowledge processes to ensure a smooth transition to more circular innovation processes.

7.3 Limitations

This conceptual paper has its limitations. First, we only focus on knowledge governance and within firm boundaries. We acknowledge other governance issues related to adopting the CE innovation process, which could be outside firm boundaries. Future research could examine these additional governance issues from other disciplinary perspectives, such as organizational studies and political science. Second, given that this is a conceptual contribution, our theorization of CE innovation process adoption is susceptible to researcher bias. This is because there is no systematic search of the literature. Instead, we select literature that best represents the purpose of our paper. Future research could look at applying the overarching framework in a systematic literature review study to refine the constructs and mechanisms in our framework. Third, given that this paper's purpose is to examine the intricacies within the firm, we did not consider regulatory or policy frameworks in our theorizing. This also limits our ability to provide policy implications from our conclusions. Future research could expand our overarching framework and examine, conceptually or empirically, the effects of regulatory frameworks in influencing firms' strategic orientations to reconfigure their CE innovation processes.

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