How companies innovate business models and supply chains for a circular economy: a multiple-case study and framework

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Abstract: To implement a circular economy (CE), companies are pushed to innovate respectively their business models, from a micro-perspective, and their supply chains, from a meso-perspective. Despite the increasing research on both these perspectives, there is still a knowledge gap on how companies innovate business models and supply chains for circularity. In the present study, we build on innovation management, Circular Business Model (CBM) and Circular Supply Chain (CSC) literatures and develop a theory-based framework where circularity leads to product/process/service innovation from a micro-perspective, and to possible innovation in companies' supply chains (retaining existing chains/renewing them) from a meso-perspective. Through a multiple-case study of Finnish and Italian CE pioneer companies, we validate this framework, find evidence on interplay between CBM and CSC innovation, and identify innovation strategy variants. The framework contributes to innovation management, CBM, and CSC literatures, and encourages managers willing to adopt circularity to consider innovating simultaneously both their business models and supply chains.

Keywords: *Business model innovation; Supply chain innovation; Circular innovation; Circular business models; Circular supply chains; Circular economy; Sustainable business; Multiple-case study.*

1 Introduction

Shifting to a Circular Economy (CE) calls companies for a systemic change in their product, process, and business model innovation activity, also considering all their stakeholders in the market and society (Aarikka-Stenroos et al., 2021). This is because of the systemic nature of CE: CE is known to propose a major sustainability paradigm (Aarikka-Stenroos et al., 2021; de Jesus & Mendonça, 2018), in which material and

energy loops are closed, slowed, and narrowed down in order to build a regenerative system that involves stakeholders across all levels of society (Geissdoerfer et al., 2017; Kujala et al., 2019). Due to the particularly systemic nature of CE, it is not enough for companies to settle with innovating their business models (micro-perspective), i.e., at the level of internal operations and processes: instead, they need to develop and innovate also their supply chains and related collaborations with external partners (meso-perspective) (Kaipainen & Aarikka-Stenroos, 2021). Accordingly, although innovation is recognized as a key for developing circular business (e.g., de Jesus & Mendonça, 2018; Jakobsen et al., 2021), there is a knowledge gap on how companies innovate business models and supply chains for a CE transition. This gap is of great importance, given the interplay that exists between the concepts of a business model and a supply chain in the CE domain. This interplay requires investigating circular innovation at the intersection between the micro- and meso-perspectives, entailing companies' internal business models change in the collaborative supply chains through innovation. In the present study we argue that only through considering this interplay it is possible to properly understand the emergence of circular innovations.

To date, only a few studies have tried to look at the intersection between the micro- and meso-perspectives for a CE transition (e.g., Aarikka-Stenroos et al., 2022; Geissdoerfer et al., 2018; Urbinati et al., 2017). Prior research has mostly looked at either micro- or meso- perspectives, separately, considering business models and supply chains as stand-alone, not relatable concepts. On the one hand, from a micro-perspective, prior research focused on the concept of a Circular Business Model (CBM), i.e., how CE principles are implemented in companies through the adoption of particular managerial practices, such as product design for circularity or the shift from product selling to product-service systems (PSSs) (Linder & Williander, 2017; Urbinati et al., 2017). Researchers found that such improvement, change and innovation can be either incremental or radical by nature (see Ranta et al., 2021). However, these studies neglect to examine how innovation in a CBM reflects to innovation occurring in supply chains. On the other hand, from a meso-perspective, researchers focused on the concept of a Circular Supply Chain (CSC), i.e., how companies adopting CE principles manage and innovate their relationships with their external partners or supply chain stakeholders (e.g., Farooque et al., 2019; Mangla et al., 2018; Masi et al., 2017). However, this research stream does not say much on the link between CSC and CBM innovation. Thus, current research still struggles to provide a comprehensive, systemic view that brings these two perspectives together in order to allow a deepening of how companies innovate business models and supply chains for a CE transition, or in other words, how companies' business models and supply chains interact when designed for circular innovation.

There are multiple underlying motivations and rationale for companies and their supply chains to adopt and implement circularity through innovation: the motivation can originate from changing regulation and institutions; companies' internal strategies and seeking a competitive advantage, as well as industries' sustainability and circularity road maps (Bjørnbet et al., 2021; Kaipainen et al., 2021; Ranta, Aarikka-Stenroos, Ritala, et al., 2018). When innovating for circularity over time as part of a company's strategic development, it is evident that companies consider both the development of their internal practices as well as supply chain relationships simultaneously (Kaipainen & Aarikka-Stenroos, 2021). This kind of strategic development is particularly challenging for manufacturing companies (Sousa-Zomer et al., 2017), who need to rethink their value creation logics in order to simultaneously manage their daily business with an increasing pressure of environmental regulations, access to scarce resources, and resource price volatility (Kristoffersen et al., 2020; Lieder & Rashid, 2016). However, these challenges are rarely discussed in the manufacturing industry (Sousa-Zomer et al., 2017), even though it has a key role in tackling the United Nation's Sustainable Development Goal for sustainable consumption and production (SDG12) (Kristoffersen et al., 2020). Therefore, studying how manufacturing companies can achieve circular business through innovating their business models and supply chains serves as a particularly interesting context, one not yet adequately covered in research to date.

As a first step towards filling the research gap highlighted above, we address the research question of: *"How companies innovate their business models and supply chains for implementing a CE"* When answering this question, we aim to provide knowledge at the intersection between business models and supply chains in a CE domain by bridging the micro- and the meso-perspectives of a CBM and a CSC and explore how they interplay.

Our research is structured as follows. First, by leveraging the innovation management, CBM, and CSC literatures, we build a framework where innovation for circularity demands different innovations, i.e., product/process/service innovation (micro-perspective); and retaining existing chains/renewing them with incremental or radical innovation (meso-perspective). And then, through an empirical multiple-case study of Finnish and Italian CE pioneer companies, this framework is elaborated with empirical cases in order to provide empirical evidence to the theoretically assumed interplay between a CBM and a CSC in the manufacturing industry. The findings show the interplay with different innovation strategy variants. These new insights complement the lack of understanding on what the implementation of circularity means for companies' business models and their supply chains, paying particular attention to the

manufacturing industry. Our framework and findings contribute to innovation management, CBM and CSC literatures, and encourage managers to simultaneously consider both business models and supply chains when innovating for circularity.

2 Theoretical background

Current theoretical understanding to how companies innovate their business models and supply chains for a CE builds on multiple streams of literature. We lean on established streams on innovation management of business models, supply chains, and value chains, and add to these streams with environmentally-focused innovation management literature, including insights from research on eco-innovation, sustainability-oriented innovation, and circular innovation of business models and supply chains.

2.1 Micro-perspective: Innovating business models for circularity

In general, companies strive for maintaining their business and competitiveness in the ever-changing markets by innovating their business models (Teece, 2010). Business model innovation focuses on pursuing opportunities within the changing environment (Schneider & Spieth, 2013) through "the conceptualisation and implementation of new business models that can comprise the development of entirely new business models, the diversification into additional business models, the acquisition of new business models, or the transformation from one business model to another" (Geissdoerfer et al., 2018, p. 406). Traditionally viewed, the changes of the value components in a business model innovation can be built around a product or a service (Mitchell & Coles, 2004), with either gradual/incremental changes, or radical changes, such as moving from product-oriented business to services (De Reuver et al., 2013). When innovating a business model from one model to another, transformation can affect the entire business model by changing one or more of its key elements, value proposition, value creation and deliver, value capture, and the interrelations between the elements (Geissdoerfer et al., 2018).

Innovating a business model to be sustainable and circular has been of interest in the prior research from a micro-perspective of CE implementation (e.g., Centobelli et al., 2020; Inigo et al., 2017; Laukkanen & Patala, 2014). Innovating a business model with a circular approach reflects on the process through which companies create, transfer, and capture value in a circular manner (Linder & Williander, 2017). Circularity changes the way the components of business models are designed and developed, and

demands considering opportunities for reducing, reusing, and recycling of material flows within the business model (see e.g., Ranta et al., 2018). Such innovation can necessitate different levels of change: Ranta et al. (2021) found that companies aiming to pursue economic and environmental value and benefits from circularity were led by incremental and/or radical improvements/innovation (Ranta et al., 2021).

The literature stream of CBM points out that companies that want to innovate their business model according to CE principles need to adopt particular managerial practices within their internal boundaries (Ünal et al., 2019; Urbinati et al., 2017), such as product design for circularity, design out waste, or the shift from product selling to product-service systems (PSSs). In the CE domain, these practices touch upon three main units of change: processes, products, and/or services (e.g., Bocken et al., 2016; Jakobsen et al., 2021) This categorisation is aligned also with the main types of eco-innovation (Triguero et al. 2013). First, when the change is focused on the process, companies can pursue circularity in their business model through innovating their processes to favour the closing, slowing, and narrowing of materials and energy according to CE principles (Engez et al., 2021). Second, when the change is focused on products, companies typically consider the nature of their products to prolong their life cycle and reduce the environmental impact, as well as how the resources and components inside these products could be upcycled, downcycled, or recycled when they reach their end-of-life (Franco, 2019; Urbinati et al., 2019). Third, as circularity engages companies to generate money from the delivery of new value propositions, companies are challenged to design new value capture mechanisms. These mechanisms imply a shift from product selling to service selling, which is aimed to extend the producer's responsibility for the product, let the customer be a user and not a buyer, thus avoiding the generation of waste by the customer. These mechanisms can take place through pay-per-use (e.g., leasing or renting) or pay-per-performance (Bocken & Ritala, 2021), and by developing reverse logistics and take-back systems, which are designed to take back the product from the customer by the producer (Ranta et al., 2018; Engez et al., 2021). Such changes in business models inherently require typically also innovation and change in supply and value chains, which is discussed next.

2.2 Meso-perspective: Innovating supply and value chains for circularity

As far as a meso-perspective is concerned, a central stream of research interest has focused on exploring how innovation expands beyond companies' boundaries to their supply and value chains. Indeed, innovation strategies are characterised by their value chain structures, which is a key part of a business model (Denicolai et al., 2018). Thus,

when companies innovate their business model, usually they need to look outside for receiving support from other organisations; particularly in their supply and value chains, in terms of new resources, capabilities, and know-how (Aarikka-Stenroos et al., 2014). This idea is not new to streams of innovation management, such as sectorial systems of innovation (Malerba, 2002), innovation systems (Laukkanen & Patala, 2014) and innovation ecosystems (Ritala et al., 2013). Supply chains refer to a network of organisations that engage in various processes and activities through upstream and downstream linkages, in order to produce value for consumers, with products and services (Christopher, 2011). When this value creation for stakeholders is enhanced through an incremental/radical change of supply chain network, technology, or process occurring in a supply chain, an industry, or a company function, we are discussing supply chain innovation (Arlbjørn et al., 2011). Supply chain innovation can enhance service effectiveness, improve operational efficiency, increase revenue, and maximise joint profits through information and related technology developments and new marketing and logistic procedures (Bello et al., 2004).

In the CE domain, especially, there is an emerging discussion about the design of CSCs, where the actors collaborate in an innovative way in order to achieve circular flows of products, by-products, and waste and to extend the product life cycle: this concerns both upstream and downstream phases of the supply chain (De Angelis et al., 2018; Govindan & Hasanagic, 2018). Turning traditional linear supply chains into CSCs calls for reverse logistics and take-back systems within a single supply chain, or for expansion to a multi-actor supply network that can include actors beyond existing industry boundaries (De Angelis et al., 2018). Thus, for CSCs, it is also typical that collaboration and communication expands from classic supply chain actors to encompassing Non-Governmental Organisations (NGOs), governmental institutions, and other organisations (Aloini et al., 2020; González-Sánchez et al., 2020).

Based on the existing literature on this topic, there are three main ways to innovate a CSC: (i) to redesign the upstream phase of the chain, modifying the collaborations with the suppliers and with the suppliers' suppliers; (ii) to renew collaborations with downstream actors of the supply chain, including customers and end-customers (these two options for change remain typically incremental innovation in terms of how much they impact the company and its encompassing environment); and (iii) to combine the approaches (i) and (ii), with the aim to address both the upstream and downstream phases of the supply chain simultaneously (see e.g., Bressanelli et al., 2019; Zhu et al., 2010). This is the most radical way to innovate supply chains.

Based on the literature review above, the necessity of collaboration to design CSCs becomes a key principle of CE. When reflecting on the CSC literature, however, it becomes of paramount importance to investigate how collaborations take place between supply chain actors in order to favour the closing, slowing, and narrowing of resource loops (Farooque et al., 2019), and how they may impact the design of companies' business models. Although more recent research has shown that CSCs can play a key role in innovating companies' business models and supporting their circular design (Aarikka-Stenroos et al., 2022), further theoretical and empirical effort is required in order to advance knowledge at the interplay between CBMs and CSCs.

2.3 Linking the micro- and meso-perspectives of circular innovation in order to build a framework

To link CBM approach addressing the micro-perspective and CSC approach addressing the meso-perspective innovation towards circularity, we next constructed an integrative framework in order to create a more comprehensive understanding of circular innovation in the intersection of these two approaches. Previous studies have indicated that this intersection requires more research: Aarikka-Stenroos et al. (2022) found that companies starting to implement CBMs developed and launched diverse innovative processing technologies, products and services and that their circular supply chains played crucial role in driving and enabling this change. Zucchella and Previtali (2019) found that CBM innovation may be fueled by CSC collaborations modifying the value proposition, value delivery, value transfer, and/or value capture of the business model.

By interpreting and drawing from the existing knowledge on CBM and CSC research streams, we had a theoretical framework that captures the key insights from both literature approaches and pays attention to the level of needed change and innovation by distinguishing radical and incremental innovation. We shaped this framework as a matrix (see Figure 1).

Radical innovation ***Incremental innovation*** ***No change/innovation***	Potential variants of circular innovation strategies		
Innovation for CSCs (meso) ***Innovation for CBMs (micro)***	***Process innovation***	***Product innovation***	***Service innovation***

Figure 1 Theoretical framework.

From the micro-perspective, circularity tends to necessitate innovation in companies' business models. Therefore, on the *x-axis* we distinguish whether the innovation in a CBM is focused on a process, a product, or a service. Typically, innovating the business model with process or product-orientation is less radical compared to shift towards a service-oriented business model (e.g., De Reuver et al., 2013). The changes in processes, products, or services are also associated with innovation in the supply chain (Gao et al., 2017). From the meso-perspective, the question is how much change is needed in the current supply chain collaborations in order to support the innovation of companies' CBMs. Therefore, on the *y-axis* we distinguish the options for designing CSCs between no change/innovation, incremental innovation, and radical innovation. Here, the degree of circular innovation of the supply chain varies from incremental to radical; we consider the innovation as incremental if the company modifies either its upstream or downstream phase, or both, in a moderate way, whereas the radical innovation of the supply chain demands the designing of entire new supply chain collaborations from both upstream and downstream phases with a major impact in the business environment. If the supply chain remains the same, there is no change/innovation in the supply chain collaborations.

What happens at the intersection of the implemented innovation from the micro-perspective and from the meso-perspective defines different types or variants of circular innovation strategies. This is what we proceeded to investigate with the following empirical case study.

3 Research design

To develop the understanding on how companies innovate their business models and supply chains for implementing CE, we next elaborated on and defined the applicability and functionality of the theoretical framework depicted in Figure 1 by leveraging an empirical multiple-case study. We carefully sampled a total of 10 Finnish and Italian case CBMs, implemented as a specific business branch by companies that have a CE mindset and that are implementing CE as pioneers in their industries, and with particular reference to the manufacturing industry context. The cases represent CBMs that are recognised as pioneers in their field, thus they serve as instrumental cases. The companies were purposefully selected from a wide range of sectors, from

oil & energy sector to retail, and from furniture industry to electronics in order to provide generalisability to the applicability of the developed framework.

The multi-source data entails interviews, group discussions, annual reports, and other secondary data sources on the CBM and CSC design at each of the case companies. In the empirical multiple-case study, we took a deductive approach and utilised the theoretical framework in order to systematically analyse and map CE pioneer cases based on how they have innovated their CBMs, with process/product/service focus, and CSCs, through maintaining or renewing the supply chains with a varying degree of innovation, i.e., no innovation/change, incremental or radical.

Table 1 Selected CBM cases, characteristics of companies, and data sources

Circular business model cases	*Case company industry, size (number of employees) & revenue (Million euros, Me)*	*Data sources*
Water packaging CBM	Food & Beverage > 250 employees, 320 Me	Interviews, secondary data
Textile re-processing CBM	Textile industry 10 employees, 26 Me	Interviews, group discussions, secondary data
Soil circulation CBM	Construction industry 10 000 employees, 3 310 Me	Interviews, secondary data
Biofuel CBM	Oil & Energy industry 4 850 employees, 15 150 Me	Interviews, group discussions, secondary data
Appliances refurbishment CBM	White appliances 25 employees, < 1 Me	Interviews, group discussion, secondary data
Techno-polymers' lamp CBM	Materials & Polymers 300 employees, 150 Me	Interviews, secondary data
Ready-to-assemble furniture CBM	Furniture manufacturing 250 employees, 90 Me	Interviews, secondary data
Marble based textile CBM	Textile industry 2 employees, < 1 Me	Interviews, group discussion, secondary data
Tools-as-a-service CBM	Manufacturing tools 237 employees, 64,6 Me	Interview, group discussion, secondary data
Coffee cups as a service CBM	Food & Beverage > 250 employees, 2 000 Me	Interviews, secondary data

4 Findings

The findings from the case analysis allow us to position the cases according to the theoretical framework (Figure 1). The positioning is displayed in Figure 2, which shows the diversity of variants for circular innovation strategies by the studied case companies embedded in their supply chains and involving varying degrees of innovation to both the micro- and meso-perspectives. Each case is briefly explained and analysed next.

Radical innovation	*Biofuel CBM:* Sourcing residuals and waste for processing bio-based fuel	*Marble-based textile CBM:* Combining two separated supply chains for new product development *Ready-to-assemble furniture CBM:* Sourcing recycled materials for furniture production	
Incremental innovation	*Soil circulation CBM:* Collecting and transporting soil between construction sites *Textile re-processing CBM:* Re-processing used textile materials for producing workwear	*Techno-polymers' lamp CBM:* Products made with additive manufacturing distributed with a new downstream chain	*Coffee cups as a service CBM:* Collecting used materials back from the offered service *Tools as a service CBM:* Comprehensive tool service with a monthly fee to industrial customers
No change/innovation	*Water packaging CBM:*	*Appliances refurbishment CBM:*	

	Treatment of recycled plastics	Sourcing for manufacturing refurbished products	
Innovation for CSCs (meso)			
Innovation for CBMs (micro)	***Process innovation***	***Product innovation***	***Service innovation***

Figure 2 Sampled cases mapped according to the theoretical framework

4.1 Process-oriented CBM innovation

For the water packaging, textile re-processing, soil circulation, and biofuel CBMs, the innovation necessary to enable circularity has its core within the internal processes.

Water packaging CBM

The main issue for the water packaging company was reducing the use of virgin plastic materials in the manufacturing process, being concerned about the environmental impact, as well as pushed by an evolving normative context addressing this issue. By serving large beverage companies, the company addressed the value creation in the CBM basing it on the development of a new internal manufacturing process, requiring purposively designed different settings for existing equipment and the addition of a pre-treatment phase. The new process allowed the company to introduce an increasing amount of recycled plastic as input materials for production. The extant supply chain of the company has been involved in the process innovation, and new specific supply contracts for the recycled plastic input have been signed. However, while no significant innovation has been put in place at this level, the company is exploiting its existing relations with suppliers.

Textile re-processing CBM

Due to the significant environmental impact of the textile industry and the values of pioneering companies in the field, a workwear company designed a textile re-processing CBM. The company tailors workwear for their customers, primarily service companies, and produces the workwear primarily in its Baltic production sites from ecological and recycled textile materials. The value creation in the CBM is based on the process innovation that allows extracting the fibres from used textiles and re-organising them for manufacturing new products, designed with circular principles. The supply chains are built in close collaboration with material suppliers and

subcontractors in order to meet the CBM's needs, but they do not reflect a significant innovation or change taking place to enable the business model: only incremental innovation shows in the downstream chain, as customers are able to send back their used textiles for re-processing and re-production.

Soil circulation CBM

The soil circulation CBM was initiated by a traditional, large industrial construction company in order to avoid logistics and landfill costs from the usage of soil materials. Instead of ordering new soil and dumping the used soil, the CBM allows circulating the soil materials within and between construction sites. At the heart of the CBM to create value is the process for circulating the soil material. To do this, the construction company has developed new processes to collect and transport the soil from one construction site to another, including the design of the reverse logistics within the upstream supply chain that reflect incremental innovation to the supply chain collaborations.

Biofuel CBM

The biofuel CBM was created within a traditional energy & oil company that realised it could not survive with fossil-based business and wanted to explore new, sustainable ways of producing fuel for road and aviation transportation. At the core of the business model innovation for circularity is the technology that allows processing the globally sourced renewable feedstocks into fuels and selling them with a higher price margin to customers in Northern Europe and America. The value creation in the CBM innovation is thus based on innovating the process for fuel production. Drastic changes in the supply chain were implemented in order to build a transparent supplier network for new types of feedstocks and to deliver them to customers more widely distributed with multiple contents compared to the previous linear business model: As the CBM demands renewable feedstock in high volumes, the feedstock needs to be sourced globally through completely new upstream supply chain networks that are made transparent for externals, principally the customers. At the same time, the downstream supply chains have changed with not only new geographical areas interested in the renewable fuels, but also with novel customer types that have expanded over time covering other sectors e.g., the aviation sector.

4.2 Product-oriented CBM innovation

The appliances refurbishment, techno-polymers lamp, food e-commerce, and ready-to-assemble furniture CBMs focused on building a product-oriented circular offering.

Appliances refurbishment CBM

The appliances refurbishment CBM was built on the existing business of the company dealing with spare parts management and after sale services provision for a number of appliances producers. The value creation in the CBM is based on the product innovation, by bringing directly on the market, as well as the existing service business, refurbished products. Indeed, instead of discarding appliances with major failures coming from final customers, the products are fully refurbished and given a new extended life on the market. As far as the supply chains are concerned, the company was not bringing significant changes to its existing business, apart from placing additional orders for spare parts and other components needed for the refurbishment process. Given the limited size of the company, it is worth mentioning that it was able to manage the downstream activities towards the final customers internally, otherwise it could have required access (incremental innovation) to a different set of suppliers already well present in the appliances market.

Techno-polymers' lamp CBM

Similar to the previous case, the company started its CBM innovation by introducing internally a new product, based on additive manufacturing technologies, exploiting the presence inside the company of raw materials and the flexibility of 3D printing technologies in order to create a new lamp. The product that lies at the core of the CBM uses the polymers' scraps from the manufacturing process of the company, which allows the company to enter in a new market, i.e. the lighting segment for final users, quite far from its existing B2B business. As a consequence, the company had to innovate also the supply chains to which it connects. In particular, a new-to-the-company network of suppliers was accessed in order to reach the final market, thus representing an incremental innovation to the supply chains.

Ready-to-assemble furniture CBM

The ready-to-assemble furniture company was initially in the business of supplying wood components for furniture producers when it decided to develop a completely new product based on 100% recovered materials. The value creation in the CBM deals with a product innovation which is able to exploit exhausted furniture as a source of input for new furniture. As well as the development of the new product, the company had to radically innovate also its supply chain. Indeed, there are existing actors in its network providing the supply of exhausted furniture, that was normally treated as waste and therefore managed by waste recollection companies. The ready-to-assemble furniture company intestinally created and developed a consortium of actors for collecting and recovering the material required.

Marble based textile CBM

To respond to the needs of the market that highlight the high performance and a more responsible impact of textile materials, and to reduce waste materials in the marble industry, the company innovated a CBM with marble-based textiles. Using the powder of marble, usually a scrap of the manufacturing process for marble products, as an additive for creating a completely new marble-based textile product is the core idea of the CBM innovation of the company. In this case, the product innovation for circularity has required a radical change in the supply chains. Indeed, the company was obliged to implement radical innovation in order to operate through connecting two previously distinct supply chains: the supply chain of marble products and that of textiles. This connection between the two supply chains radically modifies the usual chain of players in the industry and creates a unique symbiosis between the two industries via the supply chains.

4.3 Service-oriented CBM innovation

As for the service-oriented innovation for offering a circular solution, only two of the sampled cases were identified. Those were the coffee cups as a service CBM and the Tools as a service CBM.

Coffee cups as a service CBM

Being concerned about the environmental impact of exhausted coffee cups produced by the company to serve the consumer market, the coffee provider company initiated coffee cups as a service CBM. The value creation of CBM deals with a completely new service designed by the company to provide the needed cups to the customers, ensuring at the same time the take back of exhausted ones. Exhausted cups are treated in order to recycle the technical material (aluminium) and produce compost with the organic residues. The coffee cup as a service CBM uses the extant chain to reach the final customer and implies incremental innovation in the downstream of the supply chain by connecting with two new for the company but already existing supply chains for exploiting the exhausted coffee and the recovered aluminium.

Tools as a service CBM

The industrial tools company provides tools to construction, energy, and manufacturing businesses, which all are material- and energy-intensive and are facing the crucial need for implementing sustainable solutions demanded by global regulations. The tools as a service CBM is based on renting industrial tools to customers with a monthly fee that covers costs of use, repair, and insurance for theft. The value logics of the CBM lean on service innovation. The supply chains in the CBM

support the supply and distribution of the tools, as also non-service-based business models of the company. An incremental change to the supply chains is present by the repairing and collection of used products from the customers. However, the tools collected from customer rental are not re-distributed for new customers in a closed-loop supply chain, but instead thrown away.

5 Discussion

When positioning the empiric cases into the theoretical framework, we are able to draw observations on the key aspects of the circular innovation, acknowledging both CBM and CSC approaches. Our structured analysis and positioning of cases in the framework allow us to find evidence of the assumed circular innovation strategy variants that differ in terms of CBM innovation (micro-perspective) and required CSC innovation (meso-perspective).

In the micro-perspective (X axes in Figures 1 and 2), we see that the business model innovation showcases through innovation of processes, products, and services that could be expected based on the reviewed prior innovation literature. However, in the context of a circular economy, this diversity of innovation types leading to a CBM innovation has been a research gap until recently (Engez et al., 2021). Therefore, it is important to note that the studied cases manifest diverse ways in which to innovate a business model for circularity. Interestingly, despite this variation potential, most cases focused on product-oriented innovation in their CBM. This finding indicates that it may be easier for companies to start looking into their products when inducing a CBM. In contrast, the change towards service-oriented CBMs appears more restricted, although services are proposed as a viable and effective option for manufacturing companies innovating their business models to, for example, enhance the value proposition and redesign the value chains (Velamuri et al., 2013). The challenges in moving from products to services may appear when turning existing linear business models to circular, because such change is a radical and thus demanding in companies' business model innovation (De Reuver et al., 2013). We also find that the change principally related to processes, products, or services is often not strictly dichotomous and limited to only one type of business model innovation but, for example, a process-oriented innovation may trigger movement towards product- and service-oriented business model innovations (see also Kaipainen & Aarikka-Stenroos, 2022).

The meso-perspective findings (Y axes in Figures 1 and 2) display the diverse ways for innovating through circular supply chains. The empiric cases show, for example, implementation of reverse logistics (soil circulation CBM), development of supply

chain transparency tracking systems (biofuel CBM) to be outcomes of innovating supply chains when supporting a CBM. Also, connecting supply chain actors across industry borders appears in the cases (Marble textile CBM; Coffee cups as a service CBM), which is highlighted in prior circular supply chain literature as being important for enabling CBMs (Aarikka-Stenroos et al., 2022). As the illustrative cases demonstrate, a radical innovation to supply chains is demanding even for CE pioneer companies to implement in practice, although it has been researched within the sustainable supply chain innovation field more than incremental innovation implementation (Gao et al., 2017). Radical innovation of supply chains seems also to occur often together with, or as a result of, product-oriented business model innovation.

Our research reveals cases where innovation occurs only in the micro- or at the meso-perspective. However, interestingly, most of the circular pioneer companies have innovated both simultaneously. Thus, the key finding confirms our assumption that circularity demands considering and innovating not only the micro-perspective, including the business model and internal processes, but also the meso-perspective through supply chain collaborations. As we position the cases according to the theoretical framework, we find that the real-life implications for circular business entail various combinations of micro- and meso-level innovation. We call these found combinations variants of circular innovation strategies. With these strategic variants, this study is able to show how much variation there is actually in the two dimensions, expanding from the prior research (Aarikka-Stenroos et al., 2022; Kaipainen & Aarikka-Stenroos, 2021; Ranta, Aarikka-Stenroos, Ritala, et al., 2018) that has pointed to the general need for innovation in order to enable circular economy business. With our framework, we can complement the existing understanding by showing the variation though strategic variants resulting from innovation in the two dimensions, business model and supply chain, with a varying degree of radicality. Although the existence of strategic variants that the companies imply by combining various levels of micro- and meso-perspective innovation is implicit in our findings, the likelihood and circumstances for such variants to emerge requires further research.

6 Conclusions

In the present study, we aimed to explore how business models and supply chains interact when being designed in a circular way. We compiled theoretical framework in the intersection of the micro- and meso-perspectives of the circular innovation in CBM design and conducted a multiple-case study with instrumental cases. Based on the theoretical and empirical insights, we show the evident connection between micro- and meso-perspectives in the design for circularity and display innovation strategy variants

(see Figure 2) that apply different combinations of innovation in CBM design from micro- and meso-perspectives. With the evidence from the cases that were mapped in the framework, we are able to provide empirical evidence to the theoretically interpreted linkage between micro- and meso-perspectives in CBM design, finding that the framework applies not only to theory, but also practice in real-life CBMs. According to the findings, implementing a CE demands companies to develop their business models strategically through different combinations of innovation in the CBM design (i.e., process, product, and/or service) and in the CSC design (no change/innovation, incremental innovation, and/or radical innovation). These insights provide much-needed understanding to both theory and practice of innovation management for circular business model and circular supply chain design. When selecting which combination of the micro- and meso-level innovation a company implements into its CBM, the company needs to take fundamental strategic decisions in its innovation and business management. Therefore, the framework allows companies to identify themselves within the framework based on the CBM they are executing. Here, the framework also allows them to elaborate on both their current and future choices for the circular value proposition (Ranta et al., 2020) and their value creation within the processes, products, and/or services in the micro-perspective of a CBM. Meanwhile, the decisions made in the meso-perspective for innovating circular supply chains may impact incrementally or radically the means of companies' circular value creation (see Mishra et al., 2018; Ünal et al., 2019).

The selected combination of the micro- and meso-level innovation a company implements into its CBM serves as a strategic path for the company to pursue not only circular business model innovation, but also long-term guidelines for a circular innovation strategy. However, the variants for circular innovation strategies that are emerging from Figure 2 are not mutually exclusive, meaning that when innovating CBMs and CSCs, a company may entail and reflect features of multiple circular innovation and business strategies simultaneously. For example, biofuel CBM expanded the know-how of chemical processing in order to develop new business by innovating production of renewable plastics. Meanwhile, interestingly, as the circular innovation strategies develop over time (Kaipainen & Aarikka-Stenroos, 2021), the strategic decisions within the logics for value proposition and creation in the CBM also evolve over time. Accordingly, companies may possibly move together with their CBMs from one circular innovation strategy variant to another as the time passes.

6.1 Contributions to theory

We are among the first to present a framework that reveals the interplay between the micro- and meso-perspectives of CE, involving innovation to processes, products, and services from the micro-perspective of a circular business model, as well as from the meso-perspective in the design of circular supply chains. Thus, our findings and proposed framework have multiple contributions to theory, particularly in innovation management research, as well as in the intersection of the addressed literatures of CBM and CSC.

For innovation management research, the findings strengthen the understanding of the interlinkage between two major types of innovation, those of business models and that of supply chains, strengthening the understanding of diversity of innovation types (e.g., Garcia & Calantone, 2002) in the context of a circular economy (Brown et al., 2021; de Jesus & Mendonça, 2018). Our study extends and sharpens earlier research discussing diverse circular innovation types (Engez et al. 2021) and levels of novelty (Ranta et al. 2021) that can lead to CBM innovation. Also, our study displays the variation of circular innovation and structures and theorises this variation by utilising the two innovation perspectives (micro- and meso-perspectives) and distinguishing radical and incremental change. From the perspective of CBM research, the proposed and empirically elaborated framework brings new knowledge to the ways circularity can reflect in the innovation of processes, products, and services of a company in order to create, transfer, and capture value in a circular way (Franco, 2019; Urbinati et al., 2017; Ranta et al. 2021). Then again, taking the perspective of CSCs, the axes of the framework complement the lack of understanding to the key dimension through which companies can implement a CE in practice in their supply chains through innovation, and integrate it in their business models by developing their collaborations with other organisations in their supply chains in order to achieve circular goals (De Angelis et al., 2018).

6.2 Practical implications

Our study has several practical implications aimed at company managers who are willing to apply circular principles in their business and increase the degree of circularity within their companies. By identifying the company CBM according to their positioning within our framework, company managers will be able to learn about the available directions in which they can continue developing their circular strategic combinations of innovation, to be applied to their business models internally and/or within supply chains.

Above all, we call managers who want to innovate a CBM to think in a more systemic way: to not only (re)design their CBM starting from their internal boundaries, but also simultaneously to expand their view into their supply chains. As this study shows, the innovation of a CBM necessarily goes hand in hand with CSC collaborations, and thus pursuing circularity in companies demands open-mindedness towards holistic and systemic circular innovation strategies, involving both micro- and meso-perspectives.

6.3 Limitations and avenues for future research

We acknowledge that our study has also some limitations: we focused on developing CBMs and circular business, rather than the process of developing particularly a circular process/products/service. As our study analysed a set of selected cases, more generalisability could be pursued with additional cases and with an extended data collection and analysis. Furthermore, the discussed framework and the appearing variants of circular business models and strategies (see Figure 2) could be investigated more in-depth by addressing a specific set of circular innovation strategy archetypes, as well as their linkages in order to develop business strategies to circular. This qualitative research aimed to take the first step by uncovering the variation of innovation for circular business and should be continued by further studies on why variation and the possible archetypes emerge, and how to manage simultaneous innovating of the business models and supply chains – this direction would link the topic to companies' capabilities and motivations to innovate. More thorough investigation of these emerging circular innovation strategies, their possible archetypes, and their dynamics over time could be allowed, for example, with application of longitudinal case research. Here, as the companies innovate strategic changes to the micro- and meso-perspectives of their business models, future research could look into the path dependency and path creation (Garud et al., 2010) during the development of companies' circular innovation strategies over time. Furthermore, more research is needed on how innovation in CBM and CSC leads to circular transformation and renewal of particularly environmentally burdensome industries, for example, textile or construction, and how the disruption in such industry-crossing technological systems can be managed by aligning companies' CBM innovation and related CSC innovation.

There are also multiple research avenues beyond the specific setting and context of our study. The framework may serve useful also in identifying and analysing innovation strategies not limited to circular economy context. Furthermore, our study is focused on manufacturing companies, and thus leaves room for future research to investigate further the applicability of the framework in other types of industries. Also, our study

does not take explicitly into account country-specific factors affecting the analysis, allowing for a further extension to other geographical contexts and comparisons.

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