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Review

Toward a circular value chain: Impact of the circular economy on a company's value chain processes

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ABSTRACT

On their way toward a circular economy, companies are often unsure how circular solutions will affect their organization. Uncertainties due to a design over multiple life cycles and a complex interconnectedness with diverse stakeholders make circular economy effects difficult to predict. This study contributes new knowledge on the implementation of a circular economy by analyzing the implications of circular solutions for a company's value chain processes. In a systematic literature review, potential implications of a circular economy are structured along Porter's value chain framework and seven overarching main topics are identified. They refer to stakeholder collaboration, consumers' perception, Industry 4.0, performance measurement, multiple life cycle thinking, circular economy-specific skills, and a supportive top management and corporate culture. The analyses show that the linear structure of Porter's framework is not sufficient to reflect circular business practices, requiring changes toward a circular and interconnected view. Therefore, a circular value chain model is newly proposed which adapts the traditional management perspective of a company's operating model to circularity. The study connects insights from management and circular economy research, integrates circularity in managerial thought patterns, and supports strategic decision-making in a circular economy context.

1. Introduction

"There is only one planet Earth, yet by 2050, the world will be consuming as if there were three." (European Commission, 2020, p. 2, p. 2)

The circular economy (CE) has become an increasingly popular industrial concept, which aims to alleviate a future resource scarcity and environmental challenges like CO_2 emissions (Ellen MacArthur Foundation, 2013; Sarja et al., 2021). Therefore, a variety of stakeholders such as governments, companies, and investors are integrating circularity in their strategy to achieve climate targets and improve environmental sustainability. A CE is defined as an *"industrial system that is restorative or regenerative by intention and design"* (Ellen MacArthur Foundation, 2013, p. 7) and keeps *"products, components, and materials at their highest utility and value at all times"* (Ellen MacArthur Foundation, 2015, p. 46). Two types of circular solutions can be distinguished: Closed cycle solutions create biological material cycles, for example by extracting biochemical feedstock, or technical material cycles, generated by maintenance, reuse, refurbishing, remanufacturing, or recycling (Ellen MacArthur Foundation, 2013). Systemic solutions refer to product-service systems (PSS) such as leasing, sharing, or pay-per-service offers and to larger systemic solutions like connected multi-modal mobility systems (Ellen MacArthur Foundation, 2015; Tukker, 2015).

Circular solutions often require major shifts in a company's business and operating model that lead to high levels of risk and uncertainty (Govindan and Hasanagic, 2018; Hofmann and Jaeger-Erben, 2020). CE research has revealed that the introduction of circular solutions strongly impacts organizational processes and strategic agendas (Pinheiro et al., 2019). To reflect a company's business activities, management literature has developed various frameworks, which aim to improve corporate performance. Whereas frameworks like the business model canvas (Osterwalder and Pigneur, 2010) analyze business activities from a strategic and conceptual point of view, Porter's (1985) value chain framework takes a more operational and processual perspective. It regards the value chain in a holistic way including both primary

Abbreviations: CE, Circular economy; CSC, Circular supply chain; HR, Human resources; PSS, Product-service systems.

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activities such as logistics or production and support activities such as human resources (HR) management or accounting.

Management research is still strongly oriented at linear thought patterns, deriving from a long history of economic development (Lieder and Rashid, 2016). In contrast, CE literature provides a circular value chain approach in the context of circular supply chain (CSC) management. A CSC is concerned with *"the configuration and coordination of the supply chain to close, narrow, slow, intensify and dematerialize resource loops"* (Geissdoerfer et al., 2018, p. 713) and is partly referred to as circular value chain. A CSC shows the steps of value creation that contribute to a CE by closing material loops. These steps usually include purely product-related activities such as material sourcing, design, manufacturing, distribution & sales, consumption & use, collection & disposal, and recycling & recovery (Kalmykova et al., 2018; Vegter et al., 2020). From a company's perspective, the CSC takes a narrower view than Porter's (1985) holistic value chain understanding which includes additional support activities such as HR management, accounting, and innovation management. Therefore, it would be valuable to investigate Porter's (1985) value chain in the context of a CE and analyze CE implications at the firm level from the perspective of traditional management research.

Limited CE-related studies have been conducted in management research but CE research provides a variety of insights regarding a transition toward the CE. Several literature reviews are concerned with specific types of circular solutions such as PSS (Tukker, 2015) or organic solid waste management (Paes et al., 2019). Other reviews (e.g., Alhawari et al., 2021; Geissdoerfer et al., 2017; Lieder and Rashid, 2016) take a more general view of the CE. Merli et al. (2018) give a comprehensive overview of CE research but do not specifically investigate CE implications for companies. Further reviews examine the firm perspective. However, most company-related CE knowledge is scattered across different research streams, for instance Industry 4.0 or drivers and barriers for CE implementation (Awan et al., 2021; Awan and Sroufe, 2022; Sarja et al., 2021).

Two literature reviews (Farooque et al., 2019; Hazen et al., 2021) summarize CE implications for organizational processes in the context of CSC management. Farooque et al. (2019) identify important aspects of CE implementation along the CSC without detailing operational implications. Hazen et al. (2021) analyze how company-internal supply chain processes can support CE implementation, mainly referring to supply chain rather than CE literature. Both reviews take a CSC perspective centering only on product-related activities. In a conceptual study, Pavel (2018) discuss the importance to investigate Porter's (1985) more holistic value chain understanding in the context of a CE. However, they do not conduct in-depth analyses of circularity effects on value chain processes, nor does existing research provide a systematic literature review focusing on this topic. Considering this research gap combined with the fact that most value chain-related CE knowledge is scattered across literature, there is a need for a systematic review, which structures scattered CE knowledge and gives a comprehensive overview of CE implications for a company's organizational processes. The following research question is investigated in this article:

> Which implications does the introduction of circular solutions have for a company's value chain processes?

Following Tranfield et al. (2003), this study conducts a systematic literature review to connect insights from CE literature with management research and to analyze CE implications for linear business models. CE implications describe the required changes and aspects a company has to consider when introducing circular solutions. The review is structured along Porter's (1985) value chain framework because it reflects a company's strategic activities holistically from an operational and processual point of view and, thus, establishes a suitable basis for the literature analysis.

Seven overarching main topics are identified for CE implementation referring to external stakeholder collaboration, consumers' perception, Industry 4.0, performance measurement, multiple life cycle thinking, CE-specific skills, and a supportive top management and corporate culture. A new circular value chain framework is suggested which extends Porter's linear view to a circular business understanding. By examining the implications of circular solutions from a traditional management perspective, this study shows how linear thought patterns in management research have to be changed when implementing a CE, for example by adopting a circular view of material flows and a multiple life cycle perspective. The study thus enables organizations and management scholars to view the CE perspective as a new paradigm that challenges the current linear perspective. Furthermore, it provides companies with detailed insight regarding stakeholders and changes for circularity and gives them guidance on both functional and cross-functional CE-related leadership responsibilities. The latter includes increased collaboration with the external ecosystem and between different functions throughout the entire value chain. In the following, theoretical framework and applied research methods will be described, findings will be presented and discussed, and conclusions will be drawn.

2. Framework for the review process

This review aims at analyzing CE implications from a management perspective, based on a traditional and well-established strategic management framework. For this task, various frameworks could have been chosen, such as McKinsey's 7S framework (Peters and Waterman, 1982), the business model canvas (Osterwalder and Pigneur, 2010), or the strategy diamond by Hambrick and Fredrickson (2001). However, these frameworks have a strong strategic or conceptual focus, lack a functional structure, and do not display the operational processes of a company. A more operational view is provided by CSC models (Kalmykova et al., 2018) which, however, do not include part of a company's support activities. Porter's (1985) value chain model (Fig. 1) provides a holistic view of corporate activities and divides them into functional units. It sets a strong implementation focus and is widely acknowledged in theory and practice. The value chain framework embodies the linear business understanding of a *"take-make-dispose model"* (Ellen MacArthur Foundation, 2013, p. 14) reflecting the operating model of a traditional company before the introduction of circular solutions.

Porter's value chain model was developed to identify competitive advantage. It divides a firm into strategically relevant primary and support activities (Table 1). Primary activities are concerned with creating a product and bringing it to the customer, whereas support activities assist other activities. According to Porter (1985), primary and support activities are not only linked to each other, but also have interconnections with the value chains of external stakeholders such as suppliers, channels, and customers, representing an additional source of competitive advantage.

Porter's (1985) linear business understanding reflects currently prevalent business practices. However, as structure for the literature analysis, it might lack value chain activities which are necessary for introducing circular solutions. To identify possibly missing categories, previous CE literature was consulted, revealing that Porter's framework covers the majority of CE-relevant company-internal value chain categories except for one, *reverse logistics & recovery*, which was added as new category to primary activities. It describes collection and recovery activities at the end of a product's life cycle that are necessary for the provision of further life cycles through reuse, refurbishing, remanufacturing, or recycling (De Angelis et al., 2018; Kalmykova et al., 2018). The adapted value chain framework served as a basis for the search process and analyses of this review.

3. Research method

This study presents a systematic literature review, combining the methodology suggested by Tranfield et al. (2003) with a framework synthesis (Barnett-Page and Thomas, 2009). In accordance with the

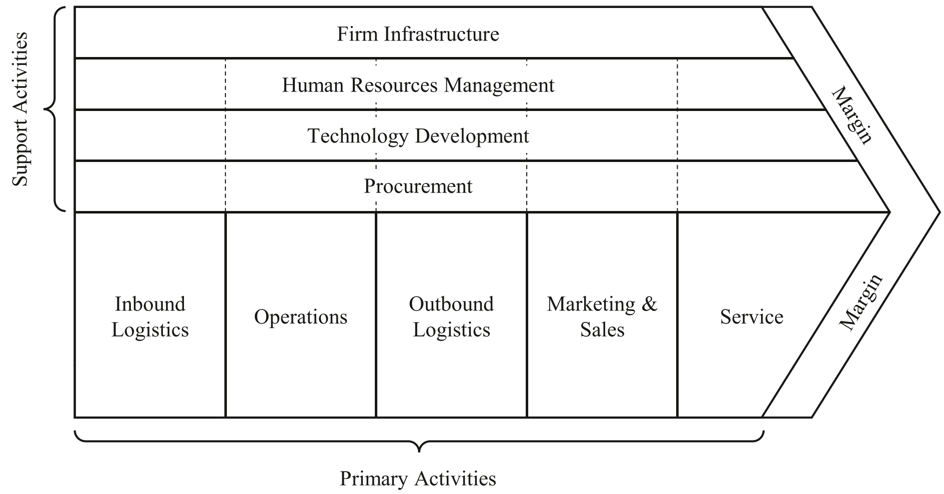

Fig. 1. Value Chain Framework (Porter 1985, p. 37).

Table 1
Primary and support activities (Porter, 1985).

Value Chain Activity	Description
Primary Activities	
Inbound logistics	Reception, storage, and distribution of materials
Operations	Transforming inputs into products
Outbound logistics	Collection, storage, and distribution of products
Marketing & sales	Attracting customers and providing them with a means by which to buy the product
Service	Improving or preserving product value
Support Activities	
Procurement	Purchasing inputs for all primary and support activities
Technology development	Enhancing the product and the company's processes
HR management	Staff-related activities such as recruitment or compensation
Firm infrastructure	Overhead activities like general management, finance & accounting, and legal affairs

research focus, the database search was structured along the value chain framework presented in section 2. For each category, suitable search terms and synonyms were developed, based on a pre-search in circular value chain, supply chain, and general CE literature. Additionally, two informal interviews with a CE expert (partner at a CE consulting firm) and a strategy expert (partner at a large strategy consulting firm) were conducted to support the authors in validating the relevance of literature-based search terms for each value chain category and adding further synonyms which are frequently used in practice. The resulting search terms were combined with the term "circular economy". A similar approach was applied by Farooque et al. (2019) with the difference that they provided no synonyms for the value chain categories but included further generic terms leading to more general results than intended in this review. Therefore, search terms in this study were strongly focused on the value chain categories themselves including widely used synonyms for the different categories. The search was conducted on December 19, 2020 in *Scopus* and in *Web of Science*, two common databases for CE research with a high coverage of CE-related topics (Masi et al., 2017). Search results were limited to a time frame beginning in 1990, as the CE concept had first been introduced in that year by Pearce and Turner (1990), until 2020 including early access articles for 2021. Business and management were selected as research areas, corresponding with the strong business focus of the research question. Fig. 2 shows a detailed overview of the search process.

The search resulted in 823 studies. After reading titles and abstracts, 728 articles were excluded because they had different thematic orientations, did not entail results relevant for the firm level, or were highly technical or specialized. The remaining 95 studies were read in full length and screened for information that contributes to the research focus. In 54 articles CE implications at the firm level were discussed for one or more value chain categories. These articles were, therefore, chosen for the sample. A further 13 hand-selected articles were added based on a snowball sampling approach (Berg, 1988), identifying additional relevant studies among the references of previously selected articles. This procedure led to a final sample of 67 studies, which were analyzed in a quantitative descriptive analysis (Tranfield et al., 2003) and a qualitative framework synthesis. A framework synthesis uses an a priori framework to examine and organize data (Barnett-Page and Thomas, 2009). In this review the value chain framework, as described in section 2, was taken as a basis to identify CE-relevant aspects for each value chain category.

4. Results

4.1. Descriptive analysis

Academic CE publications have been growing rapidly since 2017 (Fig. 3). No relevant studies were identified before 2013, possibly because the Ellen MacArthur Foundation (2013) published a frequently cited practitioner CE report in that year, stimulating the popularity of the concept. The sample includes a high percentage of studies from the Journal of Cleaner Production (45%, $n = 30$) which was already found to be the most important source for CE business research in earlier reviews (Jia et al., 2020).

Corresponding with previous findings (Pinheiro et al., 2019), the main geographical focus of the sample is Europe ($n = 30$), possibly due to the fact that in European politics and in public discussions the CE has a high relevance (European Commission, 2020). The sample includes only seven studies from other continents, whereas 30 articles do not favor a specific region. Forty-two articles (63%) focus on general CE topics such as drivers and barriers, whereas 25 studies (37%) cover value chain-related topics like circular innovation. The majority of articles is concerned with circular solutions from the technical material cycle ($n = 36$), in some cases also including the biological cycle. Twelve studies examine PSS, partly combined with the technical cycle. Only one article analyzes connected mobility as larger systemic solution. The remaining studies refer to the CE as such.

CE research shows a low employment of theoretical lenses, a tendency that has also been noted in previous literature reviews (e.g., Sarja et al., 2021). Only seven of 67 articles (10%) apply a social science theory and five use a theoretical framework. Applied social science theories include stakeholder theory, resource-based view, paradox theory, prospect theory, push-pull-mooring theory, theory of planned

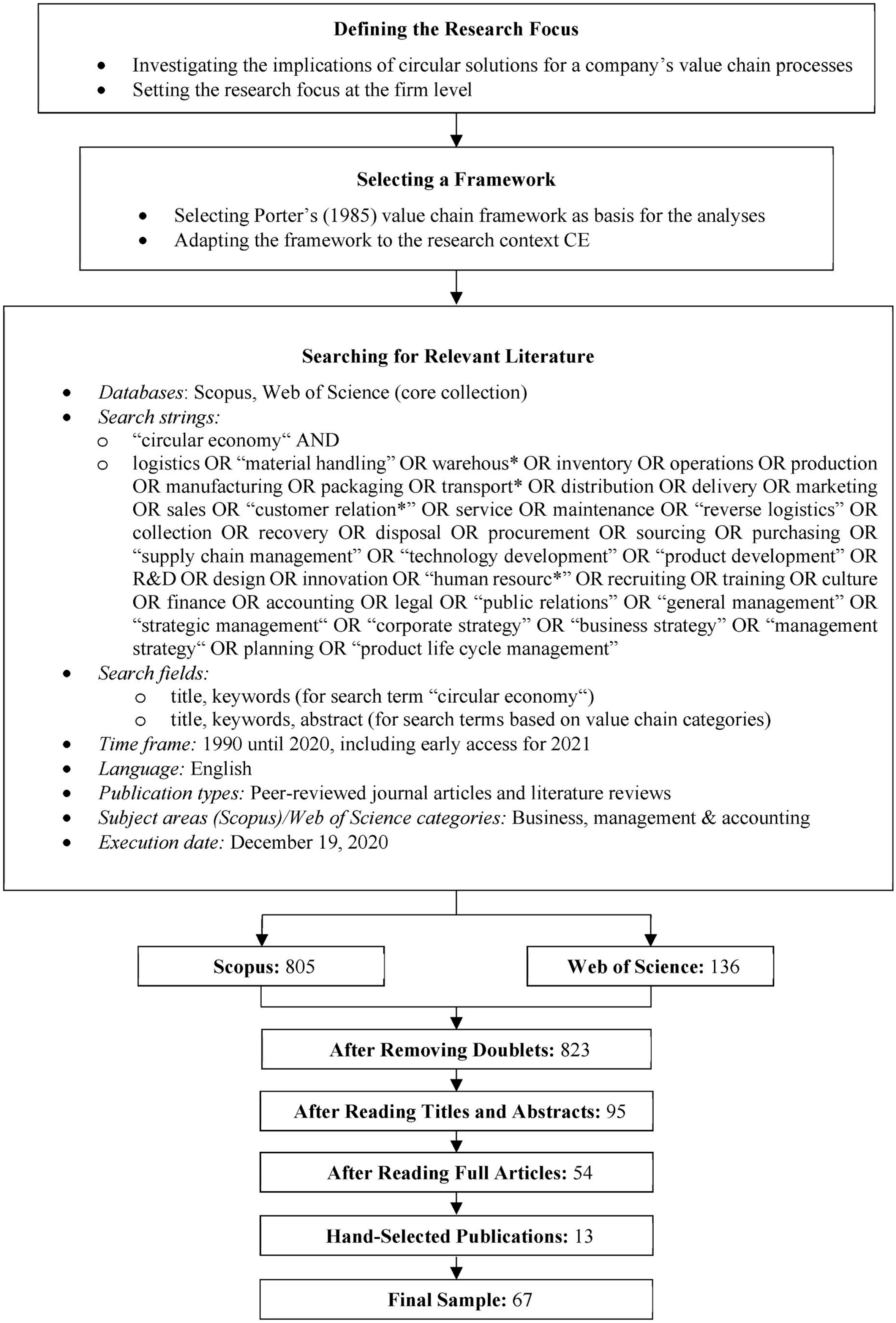

Fig. 2. Structure of the review process.

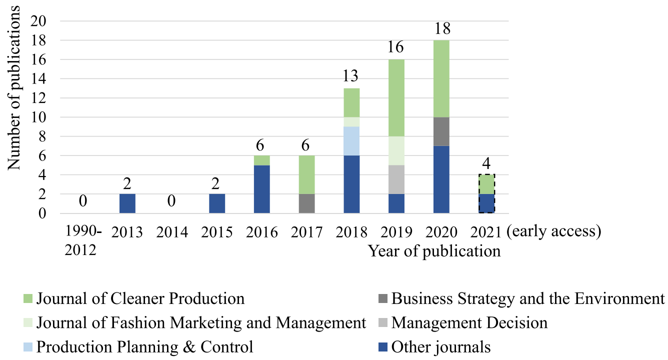

Fig. 3. Distribution of publications per year (n = 67).

behavior, institutional theory, and ecological modernization theory. In five articles theoretical frameworks such as Engel's decision-making model are used. The other 55 studies do not draw on a theoretical lens but have rather practice-oriented foci. The analyzed sample consists of 22 theoretical/conceptual (33%), 40 empirical (60%), and five mixed studies (7%). The empirical research is mainly qualitative (73%, $n = 33$) but includes nine quantitative (20%) and three mixed studies (7%) (Fig. 4). The research designs are often case studies (43%, n = 20), followed by interview studies (24%, n = 11), surveys (13%, n = 6), action research, and experiments.

4.2. Framework synthesis

In a framework synthesis the sample was examined regarding CE implications for a company's value chain processes, based on the adapted value chain framework described in section 2. Fig. 5 displays a distribution of codings according to value chain categories. *Technology development* was discussed most frequently, mainly referring to innovation and design topics. For the purpose of clarity, it was therefore renamed *innovation & technology*. The second most common category is *firm infrastructure*, which bundles the sub-categories of general management & strategy, organizational structure, legal affairs, and finance & accounting. *Inbound* and *outbound logistics* were least relevant for the analysis. These findings resemble the results discovered by Farooque et al. (2019). In their literature review of CSC management *innovation & technology* play a major role, whereas *logistics* is scarcely covered. The authors find a stronger focus on *reverse logistics & recovery*, possibly due to the inclusion of technical research areas in the database search. The categories *firm infrastructure*, *HR management*, and *service* are not included in their analyses. In the following sections, findings on CE implications are examined for each value chain category.

4.2.1. Procurement

In the value chain category *procurement*, various CE implications are identified in the existing literature. They all refer to closed cycle solutions and include costs and quality of circular materials and collaborations with internal and external stakeholders. Some companies source secondary materials to lower their costs (Ranta et al., 2018). However, they often face quality issues that complicate the processing (Jaeger and Upadhyay, 2020). Other companies develop products for closed material cycles that are to be reused, remanufactured, recycled, or composted at the end of their life cycles. Depending on the intended end-of-life treatment, the choice of materials must be adapted, for example by using regenerative, recyclable, or non-toxic materials (Ellen MacArthur Foundation, 2013), which are often scarce or of lower quality and affect original product functionalities and aesthetics (Franco, 2017; Kazancoglu et al., 2020). The range of adequate materials is even more restricted when additive manufacturing (also known as 3D printing) is applied in production, because further material specifications have to be met (Sauerwein et al., 2019). Closed cycle solutions are able to reduce the overall need for resources due to a higher material efficiency and, thus, alleviate the challenges of resource price volatility and scarcity (Hazen et al., 2021; Tura et al., 2019).

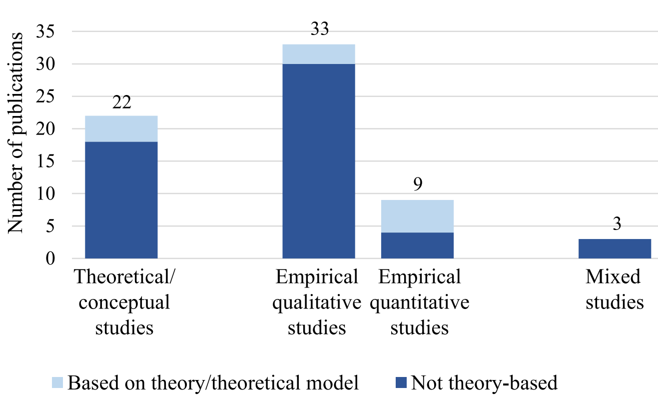

Fig. 4. Distribution of research methods and theoretical lenses (n = 67).

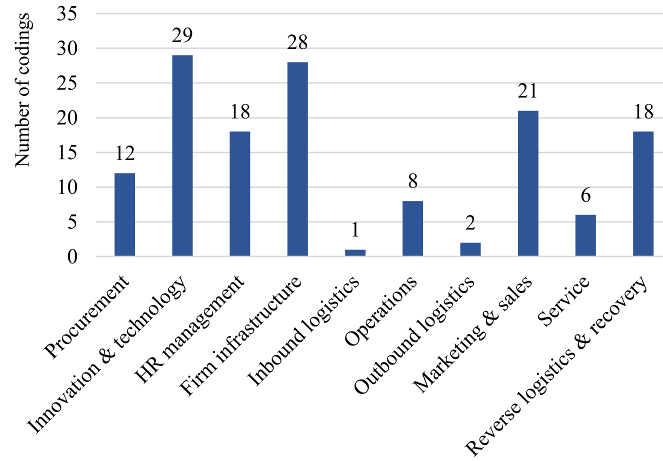

Fig. 5. Distribution of Codings According to Value Chain Categories (Multiple Codings per Article Counted as One; n = 143).

Questions of material substitution not only affect procurement but can also require collaboration with R&D or production. Especially for technical material cycles, a different product design (Kazancoglu et al., 2020) or production method (Sauerwein et al., 2019) might be necessary. In practice, changes in the choice of materials often fail because suppliers are not willing to cooperate or lack the required quality (Shahbazi et al., 2016). Therefore, long-term partnerships with suitable suppliers can offer considerable advantage (Hazen et al., 2021). However, a supplier's willingness to cooperate depends on the company's size and market power in the supply chain (Franco, 2017). CE implications for the *procurement* category are usually not discussed as a main subject in the existing literature but are rather treated as a side topic. This prioritization is surprising, as procurement is strategically important for the implementation of closed cycle solutions (Farooque et al., 2019).

4.2.2. Innovation & technology

The category *innovation & technology* refers to two literature streams: circular innovation management/product design and technology. The former comprises three CE implications. First, a collaboration with external stakeholders is essential (Hofmann and Jaeger-Erben, 2020). Companies should co-create circular solutions with the whole supply chain, especially with customers and suppliers but also with other stakeholders such as government, technical experts, designers, or research institutions (De Angelis et al., 2018; Pinheiro et al., 2019; Prieto-Sandoval et al., 2019). Low bargaining power in the supply chain might be a barrier to convincing other stakeholders of a co-creation (Franco, 2017). Although a variety of authors acknowledge the importance of involving stakeholders in innovation management, insights are mainly restricted to the necessity of a collaboration and the specification of suitable stakeholders (Pinheiro et al., 2019).

Second, various authors recommend exploratory, experimental, and agile practices for the development of circular solutions, as a CE often requires a redefinition of business, of daily routines, and of the rules of the game (Aminoff and Pihlajamaa, 2020; Hofmann and Jaeger-Erben, 2020; Jakhar et al., 2019). Regarding systemic solutions, Tukker (2015) indicates the importance of applying a modular design to the innovation process of PSS and proposes an iterative, adapted process design. Furthermore, Konietzko et al. (2020) identify stakeholder collaboration, experimentation, and platformization as principles for circular ecosystem innovation.

Third, a major challenge for the development of closed cycle solutions is a design for recovery that incorporates the end-of-life phase in the design process (Sumter et al., 2020). Many authors emphasize that the implementation of reuse, refurbishing, remanufacturing, or recycling, is possible only if products are already designed with multiple life cycles in mind (Farooque et al., 2019; Franco, 2017; Lieder and Rashid, 2016). Requirements depend on the end-of-life treatment as will be specified in the following. For reuse and refurbishing, companies should use high-quality materials, dispense with planned obsolescence, and install fault-tracking software to support product longevity (Ellen MacArthur Foundation, 2013). For remanufacturing, it is crucial to provide a modular design or design for disassembly that enables an easy deconstruction of product components (Ellen MacArthur Foundation, 2013; Hazen et al., 2021). It is of great advantage to dispense with adhesives, standardize components, and reduce product complexity (Guldmann and Huulgaard, 2020; Kazancoglu et al., 2020; Rosa et al., 2019). For the kernel of a product that passes through multiple life cycles, durable materials should be used (Ellen MacArthur Foundation, 2013). In the development of recycling or biodegradable solutions, the main challenge is to conceive a product design that integrates recyclable, regenerative, or non-toxic materials (Kazancoglu et al., 2020) (see section 4.2.1).

The second research stream, technology, mainly discusses how Industry 4.0 might support a CE but does not provide an extensive knowledge base. The following technologies are proposed: additive manufacturing produces goods in an additive, digital process without fixtures and tooling (Esmaeilian et al., 2016; Sauerwein et al., 2019). It supports product modularity, customized solutions, and the production of spare parts at the customer's location while reducing transportation and packaging (Centobelli et al., 2020; Lopes de Sousa Jabbour et al., 2018; Sauerwein et al., 2019). Cloud manufacturing enables resource sharing on a cloud platform so that customers and suppliers can interact to buy or sell services (Centobelli et al., 2020; Lopes de Sousa Jabbour et al., 2018). Combined with additive manufacturing it can link supply and demand and reduce production waste (Centobelli et al., 2020; Lopes de Sousa Jabbour et al., 2018).

Cyber-physical systems connect devices and machines by integrating cyber space, objects, and physical processes and make data available in real-time (Lopes de Sousa Jabbour et al., 2018). The internet of things describes an interconnectivity between devices and the internet and enables devices to communicate (Lopes de Sousa Jabbour et al., 2018). With sensors and unique identifiers it can track products throughout their life cycles, for example supported by a product passport (Franco, 2017; Lopes de Sousa Jabbour et al., 2018). It can also improve the efficiency of reverse logistics, as processes like sorting are often performed manually (Sandvik and Stubbs, 2019). Combined with cyber-physical systems the internet of things is able to increase resource efficiency in production, as data from machines are collected and failures are identified (Cwiklicki and Wojnarowska, 2020; Lopes de Sousa Jabbour et al., 2018). Both the internet of things and cloud manufacturing can support an understanding of customer needs and the collection of customer data to improve the quality of PSS offers (Chauhan et al., 2021; Lopes de Sousa Jabbour et al., 2018). Moreover, Industry 4.0 technologies might contribute to an exchange of information and resources throughout the supply chain (Neligan, 2018; Salvador et al., 2020).

4.2.3. *Human resources management*

CE implications in the category *HR management* refer to labor-costs, skills, employer image, and corporate culture. Both closed cycle and systemic solutions are often more labor-intensive than are linear solutions and, thus, entail higher labor costs (Tukker, 2015; Vogt Duberg et al., 2020). Furthermore, the skills of the work force must be suitable for CE-specific tasks. Relevant skills include technical expertise, systems thinking from an ecosystem perspective as well as regulatory, environmental, Industry 4.0, and CE knowledge (Chauhan et al., 2021; Chiappetta Jabbour et al., 2019; Ellen MacArthur Foundation, 2013; Guldmann and Huulgaard, 2020). Two studies are explicitly concerned with CE-related competencies for designers. The authors identify multiple life cycle thinking, skills in circular business models, stakeholder collaboration, design for recovery, communication, and technical knowledge as important prerequisites (De los Rios and Charnley, 2017; Sumter et al., 2020). Skills for the design and implementation of PSS refer to user experience, customer relations, and service offers (De los Rios and Charnley, 2017; Tukker, 2015). The implementation of a CE can improve the employer image as it embodies environmental and sustainable values (Prieto-Sandoval et al., 2019; Rosa et al., 2019). Corporate culture and the attitude of employees have a great impact on the success of circular solutions, because they can hinder or foster CE implementation (Kirchherr et al., 2018; Rizos et al., 2016). Conversely, the introduction of systemic solutions influences the self-perception of employees because corporate culture must shift from product-oriented to service-oriented (Frishammar and Parida, 2019).

4.2.4. *Firm infrastructure*

The value chain category *firm infrastructure* bundles findings for a variety of different activities, including general management & strategy, organizational structure, legal affairs, and finance & accounting. For general management, authors suggest a close collaboration in the supply chain, especially with customers and suppliers, but also in the wider ecosystem, for example with government, nongovernmental organizations, or cross-sector companies (Centobelli et al., 2020; Jia et al., 2020; Mont et al., 2017; Prieto-Sandoval et al., 2019). Such cooperation aims at the implementation of new packaging solutions, the creation of incentives to prevent the loss of material, or the development of joint standards and CE principles (De Angelis, 2020; Frishammar and Parida, 2019; Meherishi et al., 2019; Mont et al., 2017). Moreover, stakeholder collaboration can allow for information and resource sharing in a supply chain or ecosystem, supported by Industry 4.0 (Chauhan et al., 2021; Tura et al., 2019). Salvador et al. (2020) name the CE100 initiative as an example that provides an interactive CE exchange across industries. Despite broad consensus on the importance of stakeholder collaboration for CE implementation, the topic has not yet been closely examined in literature. As with circular innovation management, authors merely emphasize the necessity of stakeholder involvement and mention potential purposes of the collaboration.

A further highly relevant aspect is the commitment of top management. For a successful transition toward the CE, executives should support the adoption of circular business models, enable the development of new competencies, and provide financial resources as well as new technologies (Chauhan et al., 2021; Govindan and Hasanagic, 2018; Kazancoglu et al., 2020). Top-management commitment is also reflected in the decision to adopt a CE strategy that guides the change from linear to circular business models (Guldmann and Huulgaard, 2020). Accordingly, decision-making should not be based exclusively on economic indicators (Tura et al., 2019), and incentives should have a wider focus than the usual sales volume for new products (Guldmann and Huulgaard, 2020). Middle management should adopt a CE-friendly mindset and introduce cross-functional teams to identify CE opportunities (Hofmann and Jaeger-Erben, 2020). However, linear thought patterns are often deeply rooted in middle management, possibly necessitating personnel changes to successfully implement circular business models (Hofmann and Jaeger-Erben, 2020).

When a company integrates the CE into its organizational structure, it might consider the creation of a new separate organizational unit, first, to disentangle circular solutions from the daily business and, second, to build an experimental space (Hofmann and Jaeger-Erben, 2020). Various CE-related regulations require careful legal management to mitigate pending risks (Rosa et al., 2019), for example environmental legislation in favor of waste prevention, recycling, or extended producer responsibility (Mont et al., 2017; Tesfaye and Kitaw, 2021). Conversely, closed cycle solutions can alleviate warranty and liability risks by using less toxic and more durable materials (Ellen MacArthur Foundation, 2013; Mont et al., 2017).

In the field of finance & accounting, Svensson and Funck (2019) emphasize the importance of extending the linear mindset to a more holistic view: Performance measurement should be based on both financial and non-financial indicators such as collected waste or energy consumption. In cost accounting a more detailed long-term assessment would be recommendable (e.g., material flow cost accounting) as it faces the challenge to calculate costs and material values over multiple life cycles (Svensson and Funck, 2019). In the context of financial planning, PSS often carry more investment risk than linear solutions do because payment is received in installments (Tukker, 2015). In addition, future market demand is uncertain, as it must be predicted over multiple life cycles (Linder and Williander, 2017). For financial reporting, scholars suggest the introduction of an integrated reporting framework that takes a more holistic view than traditional approaches do and which includes both financial and non-financial aspects (Almagtome et al., 2020; Barnabè and Nazir, 2020).

4.2.5. Inbound logistics

Inbound logistics does not seem to be strongly affected by the introduction of circular solutions and is, therefore, only seldom considered by the CE literature. One implication is discussed by Salvador et al. (2021), who found that inbound logistics systems must be optimized and adapted when bioresources are concerned. Bioresources comprise renewable biomass such as feedstock used to produce food, products, or energy. Two logistical challenges are that bioresources have to be transported in large volumes and that their quality deteriorates rapidly over time. As logistics for bioresources can consequently cause high costs and have a negative environmental impact, Salvador et al. (2021) suggest a regional logistics infrastructure and adequate conditions for storage and transportation.

4.2.6. Operations

In *operations*, few CE implications are discussed in the analyzed literature, referring to product life cycle thinking, the application of Industry 4.0 in production, and manufacturing monitoring. Currently, companies focus CE initiatives mainly on material efficiency and optimized use of machinery to reduce waste or CO_2 emissions (Neligan, 2018; Tura et al., 2019). However, to achieve a sustainable CE effect, material efficiency in manufacturing should not be considered in isolation, but extended across the whole product life cycle (Neligan, 2018). Industry 4.0 technologies can help increase material efficiency and reduce production waste but can also connect different phases of the product life cycle (Chauhan et al., 2021; Cwiklicki and Wojnarowska, 2020) (see section 4.2.2). Additionally, these technologies might be applied to improve stakeholder collaboration by sharing manufacturing resources or enhancing demand management with the customer (Centobelli et al., 2020). A further CE implication refers to controlling and monitoring of manufacturing, which are usually restricted to an economic view and rarely integrate process metrics regarding natural resources and environmental flows (Hazen et al., 2021). To provide a monitoring approach more suitable for a CE, a manufacturing flow paradigm should be developed that balances the economic and environmental perspective (Hazen et al., 2021).

4.2.7. Outbound logistics

Similar to *inbound logistics*, the CE literature is also scarce in the field of *outbound logistics.* Authors focus on the effects of logistics systems, stakeholder collaboration, and location. Hazen et al. (2021) discuss options to improve outbound logistics activities according to CE principles and emphasize the importance of sustainable transportation. For CE purposes, companies might use existing logistics systems or combine different modes of transportation. Cooperative stakeholder networks can help obtain full truckloads, and a collaboration with customers can support the decarbonization of logistics. Efficiency might also be improved through closer proximity to the customer, prioritizing the local economy (Hazen et al., 2021; Salvador et al., 2021).

4.2.8. Marketing & sales

The category of *marketing & sales* is frequently examined in CE research. Findings can be segmented into general CE implications and those relating to systemic or closed cycle solutions. General CE implications refer to corporate reputation and customer collaboration. A CE can increase a company's brand value and corporate reputation, for example through an enhanced sustainability performance, high rankings in sustainability indexes, and collaborations with sustainability leaders (Rosa et al., 2019; Tura et al., 2019). To improve their sustainability image, companies should explicitly promote environmental and social CE values as unique selling propositions (Geissdoerfer et al., 2018). Furthermore, circular solutions can increase the importance of customer collaboration. Various authors have recommended the active involvement of customers in CE practices, for example in the context of joint value creation (Hazen et al., 2021; Salvador et al., 2021).

For systemic solutions, customer collaboration is particularly relevant. When PSS are introduced, the customer relationship becomes long-term oriented and encourages customer interaction (Aboulamer, 2018). This enables the collection of customer-specific data, facilitates customized offers, and enhances customer loyalty (Ellen MacArthur Foundation, 2013; Tukker, 2015). A further implication of PSS is the loss of ownership. On the one hand, the missing convenience and experience of ownership can decrease the intangible value of PSS, especially in the business-to-consumer sector (Tukker, 2015). On the other hand, the loss of ownership creates convenience advantages, as the customer no longer bears owner responsibilities like maintenance (Schallehn et al., 2019). To overcome possible reservations toward PSS, it is important to clearly communicate contract conditions and customer benefits, such as reduced responsibilities or the usage of high quality products with low upfront costs (Ellen MacArthur Foundation, 2013; Schallehn et al., 2019).

In previous research great attention has been given to the purchasing decision and customers' perception of closed cycle solutions. The purchasing decision can be influenced by perceived benefits such as a lower price and higher environmental value (Van Weelden et al., 2016; Vehmas et al., 2018) and by perceived risks such as product failure, lower quality, hygiene, and safety, which are often caused by misconceptions about the recovery process (Abbey et al., 2015; Singhal et al., 2019; Van Weelden et al., 2016). Five suggestions are proposed concerning how companies can shape consumers' perception of closed cycle solutions. First, authors suggest to educate customers about technical process, environmental value, and product features to increase awareness and overcome concerns (Van Weelden et al., 2016; Vehmas et al., 2018). Second, brand image and warranty offers could be used in the marketing strategy to build trust and to alleviate fear of quality risks (Hazen et al., 2017; Schallehn et al., 2019). Third, a low-price strategy for closed cycle solutions is recommended to enhance customer acceptance (Colucci and Vecchi, 2021; Wang and Hazen, 2016). However, the price should not be too low to avoid the suspicion of poor quality (Van Weelden et al., 2016). Fourth, credibility and awareness might be increased through word-of-mouth marketing and storytelling (Van Weelden et al., 2016; Vehmas et al., 2018). Fifth, the marketing strategy should acknowledge differences between customer segments, as for example women tend to be more willing to pay for environmentally friendly products (Atlason et al., 2017).

4.2.9. Service

Service has two main functions in a CE, either as part of closed cycle solutions or as integral part of the business model for systemic solutions. First, closed cycle solutions can provide repair and maintenance services to prolong product lifetime (Ellen MacArthur Foundation, 2013). Companies might offer tutorials and customer workshops in self-repair and caretaking, program an online tool for reparability checks, or sell individual components at moderate prices (Ackermann et al., 2018; Ellen MacArthur Foundation, 2013; Vehmas et al., 2018). A maintenance service flat rate can help overcome quality concerns (Ackermann et al., 2018). Second, in systemic solutions, the role of service changes. It exceeds the traditional value chain category and becomes an integral part of the business model, affecting the whole value chain (Tukker, 2015). Therefore, CE implications of systemic solutions are not discussed in this section but in the context of the respective value chain processes.

4.2.10. Reverse logistics & recovery

In the category *reverse logistics & recovery* literature discusses the introduction of reverse logistics and recovery processes, stakeholder collaboration, uncertain product returns, and the traceability of products. A company with linear business practices has to establish reverse logistics and recovery processes from scratch. This can be carried out in three ways. First, reverse logistics and recovery can be developed internally (Ranta et al., 2018). This requires a suitable location in proximity to customers, specialized companies, and a skilled workforce to facilitate implementation and reduce transportation costs (Salmenperä et al., 2021; Vogt Duberg et al., 2020). Second, reverse logistics and recovery can be established through partnerships with external stakeholders like waste collectors (Hvass and Pedersen, 2019). Third, services and materials for collection and recovery can be purchased on the market, for example, by paying a gate fee to waste management providers (Ranta et al., 2018).

Recycling and remanufacturing are difficult to implement if the end-of-life treatment is not already considered in product design and procurement (Sandvik and Stubbs, 2019; Vogt Duberg et al., 2020) (see sections 4.2.1/4.2.2). Customized product designs are especially challenging for remanufacturing (Yang and Evans, 2019). As the feasibility of these recovery options strongly depends on different departments, a close cross-functional collaboration is recommendable throughout the product life cycle (Hvass and Pedersen, 2019). Moreover, a collaboration with the whole reverse supply chain, including suppliers, waste contractors, recyclers, retailers, and customers, is advantageous for the implementation of reverse logistics and recovery (Campbell-Johnston et al., 2020; Hazen et al., 2021; Shahbazi et al., 2016).

In reverse logistics, customers play a crucial role, as they must be motivated to return the products after use (Pedersen et al., 2019). This is often a difficult task, for example in the fashion industry, where consumers rather give their used clothes to friends or to charity (Hvass and Pedersen, 2019). The uncertainty of product returns is one of the greatest challenges for recovery as the quantity, quality, and timing of returned products must be estimated to plan the recovery process (Kurilova-Palisaitiene et al., 2018). It can hinder the implementation of just-in-time production systems and result in long inventory storage times (Kurilova-Palisaitiene et al., 2018). Therefore, it is paramount to increase the traceability of products throughout their life cycles with the support of Industry 4.0 technologies (Franco, 2017; Kissling et al., 2013) (see section 4.2.2). The availability of detailed product life cycle data can improve collection activities and enhance the efficiency of disassembly, recycling, and sorting which is often still performed manually (Jaeger and Upadhyay, 2020; Sandvik and Stubbs, 2019).

5. Discussion

This literature review investigates CE implementation at the firm level and examines the challenges and chances companies might face when introducing circular solutions. To provide a comprehensive view of a firm's operating model, the structure of Porter's (1985) value chain framework was taken as a basis to describe CE implications for currently prevalent linear business practices. However, the findings reveal that an analysis within a linear business understanding is not sufficient to fully explain the transition toward a CE. Therefore, the graphical representation of the value chain framework needs adjustment for the context of a CE in two respects. First, the linear structure of the framework reflects a cradle-to-grave mentality which does not correspond with the cradle-to-cradle principles of a CE aiming for multiple product life cycles. As with examples of CSC models (Kalmykova et al., 2018), the framework should hence display the primary activities in a circle. Second, Porter's framework neither sufficiently shows connections between different value chain categories nor acknowledges their interrelations with external stakeholders. Both are crucial requirements for CE implementation. Although Porter (1985) mentions interfaces between value chain categories and linkages to the external value system, he mainly attempts to discover competitive advantage within each value chain category. In a CE, however, stronger interconnections are necessary which should be graphically represented in the framework. Fig. 6 presents the illustration of a circular value chain framework. It embeds a company's value chain in its ecosystem and shows interconnections between internal and external stakeholders.

The existing research covers a range of CE implications for a company's value chain. However, most topics are not studied in depth. Therefore, several future research directions could be identified. On the one hand, the prerequisites, drivers, and barriers of CE implementation need further investigation, for example in the context of different circular solutions and industries (Guldmann and Huulgaard, 2020) or on the basis of other management frameworks, such as McKinsey's 7S framework (Peters and Waterman, 1982). On the other hand, specific value-chain-related research directions could be determined along seven overarching key topics, which build main themes of the analysis and underline the holistic value chain understanding of a CE:

1. External stakeholder collaboration required throughout the value chain

The involvement of external stakeholders is a central success factor for CE implementation. It affects general management but also *innovation management*, *procurement*, *operations*, *outbound logistics*, and *marketing*. As most authors only emphasize the necessity of collaborations without further investigation (Pinheiro et al., 2019), various research gaps can be identified. First, the role of external stakeholders such as suppliers, waste managers, customers, retailers, cross-sector companies, policy makers, or society in circular business practices could be examined in the context of different circular solutions and industries (Centobelli et al., 2020; Lieder and Rashid, 2016). Particular foci might be set on knowledge sharing, collaboration mechanisms, contracts, or supply chain integration (Farooque et al., 2019) aiming to secure secondary raw materials or to establish cross-value chain standards for carbon accounting. Scholars could investigate how to create shared assets through IT platforms, material databases, material market places, or purchasing syndicates. Second, it would be of interest to explore how diverse external stakeholders can be involved in co-creation and open innovation, especially network and crowdsourcing approaches, and how the interplay between internal and external stakeholders is most effective (Aminoff and Pihlajamaa, 2020; Konietzko et al., 2020). A comparison between different types of circular solutions as well as

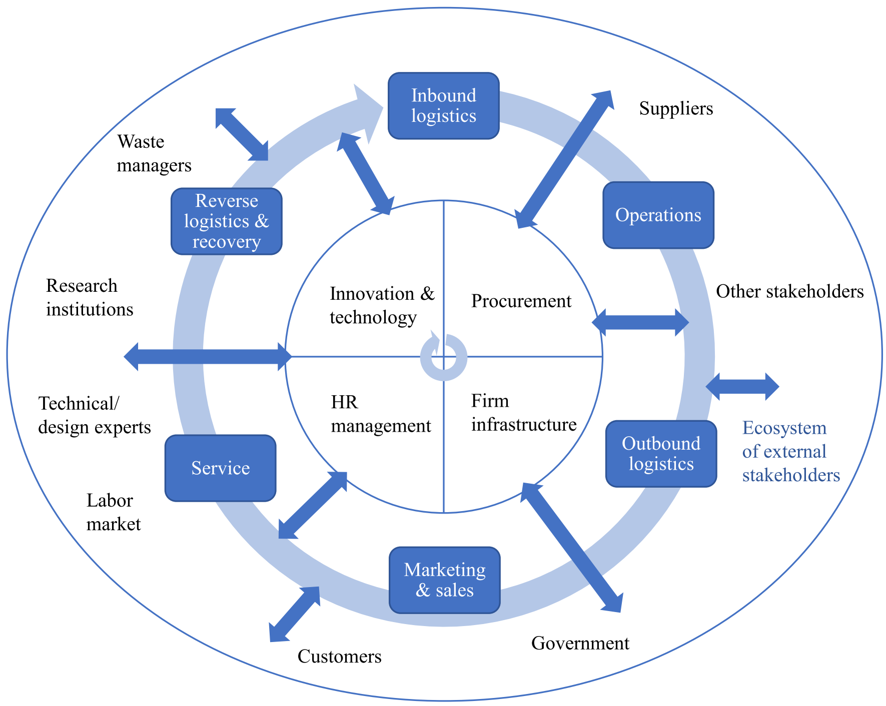

Fig. 6. Circular value chain framework.

business-to-business vs. business-to-consumer perspectives would be valuable (Eisenreich et al., 2021).

2. Customers' perception to be shaped with communication

Another frequently discussed CE topic regards consumers' perception and purchase intention for closed cycle solutions. Research in this field still lacks deeper insight regarding different circular solutions, geographies, industries, market segments, and types of provided information (Atlason et al., 2017; Singhal et al., 2019; Van Weelden et al., 2016). It would be advantageous to understand whether customers' perception differs between startups, family businesses, and corporations and if strategic CE programs and greenwashing are perceived differently. Moreover, communication strategies that are able to shape consumers' perception have to be investigated in detail (Van Weelden et al., 2016), especially the effects of transparency regarding recovery processes, quality monitoring, product functionalities, and technological obsolescence as well as the influence of different pricing strategies on consumer's perception. Authors might explore how the COVID-19 pandemic influences the perception of sharing models and how community-based systemic solutions change customer identity. Additionally, future research could focus on the role of consumers (Hazen et al., 2017) for the introduction of circular solutions, segmented according to demographic variables such as age, gender, and nationality. Scholars could analyze how incentives motivate consumers to implement circular behavior (Farooque et al., 2019) and how customer relationships change in a CE through digitalization, data collection, and customer interaction.

3. Industry 4.0 supporting circular solutions

Findings regarding Industry 4.0 in a CE were bundled in the category *innovation & technology*, but they are strongly interconnected with other value chain activities such as *reverse logistics & recovery*, *operations*, and *marketing & sales*. Considering the expected uptake of Industry 4.0 in the future, it would be valuable to investigate how Industry 4.0 technologies can support multiple product life cycles, customer retention, product traceability, reverse logistics, recovery, and supply chain relations in a CE (Cwiklicki and Wojnarowska, 2020). Scholars might examine which drivers, barriers, and prerequisites, such as costs, savings, and resources have to be regarded when applying Industry 4.0 technologies for CE implementation (Lopes de Sousa Jabbour et al., 2018; Neligan, 2018). Additionally, future research could explore how to shape and structure data repositories for PSS with Industry 4.0 and how to establish a CE-specific architecture of an industrial internet.

4. Performance measurement including non-financial metrics

The topic of performance measurement was allocated to finance & accounting in the analyses; however, the definition of performance indicators affects the entire value chain. Findings imply the importance to extend the financial perspective to non-financial metrics in management control, accounting, financial reporting, and manufacturing control. CE literature on performance measurement is scarce and needs further specification (Svensson and Funck, 2019). Future research could examine which performance measurement systems are most suitable for a CE and how the effectiveness of CE-specific performance indicators such as recycled content, recyclability, utilization rate, or reparability can be measured (Farooque et al., 2019; Hofmann and Jaeger-Erben, 2020). In this context it would be valuable to compare how product- and utility-related circular performance can be evaluated. Additionally, future studies might investigate how multi-criteria decision-making techniques can support CE implementation (Chauhan et al., 2021; Kazancoglu et al., 2020).

5. Multiple life cycle thinking required throughout the value chain

In many circular solutions, material efficiency is improved through multiple life cycles of products, components, or materials. Depending on the intended end-of-life treatment, product design and material sourcing must be adapted, leading to major changes in R&D and procurement. Considering the central role of design for recovery, it would be of great interest to further examine, how suitable methods and techniques for design for recovery can be chosen (Farooque et al., 2019) and which industry-wide standards for design for recovery can be formalized. Scholars might also explore how to solve the challenges of uncertain product returns, interrelated with the collection system and recovery type. Additionally, researchers could analyze to what extent multiple life cycle thinking can be fostered in cross-functional collaborations.

6. CE-specific skills required throughout the value chain

Various authors emphasize the importance of CE-specific skills for the transition to a CE. Skill requirements for the labor force are determined by *HR management* but are also related to categories such as *innovation*, *firm infrastructure*, or *reverse logistics & recovery*. The literature commonly lists CE-relevant skills but does not further discuss them, except for two studies concerned with circular design skills (De los Rios and Charnley, 2017; Sumter et al., 2020). As a lack of CE-specific skills hinders CE implementation (Kazancoglu et al., 2020), it would be advantageous to analyze required skill sets and the effect of individual skills such as systems thinking, multiple life cycle thinking, and collaboration skills on CE implementation with regard to different circular solutions, value chain categories, and industries (De los Rios and Charnley, 2017; Meherishi et al., 2019). It might be of specific interest to examine how the shift from a material to a performance focus and the shift from a standalone to a value chain orientation in a CE can be reflected in employees' skill sets.

7. Supportive top management and corporate culture as success factors

The mindsets of top management and employees are equally important success factors for the implementation of circular solutions, as they can impede or foster the transition toward a CE. The literature mentions mindset, top-management support, and corporate culture as relevant factors, but does not contain further investigation. Scholars could examine how corporate culture, employee and top-management commitment influence CE implementation (Centobelli et al., 2020). A specific focus could be set on the influence of open innovation, cross-functional, and supply-chain-collaboration on the CE-friendliness of a corporate culture. Additionally, different steering models such as top down vs. bottom up, functional vs. cross-functional, or collaborative vs. hierarchical steering could be compared regarding their influence on CE implementation. Future research might also investigate which types of leaders tend to promote a CE and whether women diversity in the board of directors, in the managerial or founding team has an impact on circular activities. Conversely, scholars could explore how corporate culture and the mindset of employees change after the implementation of different circular solutions and how the CE can be used as a catalyst for corporate transformation.

As the majority of the CE literature is not based on theory, future research would benefit from the application of different theoretical lenses. Examples include stakeholder theory (Freeman, 1984), social exchange theory (Homans, 1974), and institutional theory (DiMaggio and Powell, 1983), each of which could be suitable for research on stakeholder collaboration. Resource-based view (Barney, 2001; Wernerfelt, 1984) or ecological modernization theory (Spaargaren and Mol, 1992) might be used in studies on Industry 4.0 in a CE (Lopes de Sousa Jabbour et al., 2018). Resource-based view could also serve to analyze CE-specific skills. For motivational questions a commitment approach (Allen and Meyer, 1990), prosocial motivation approach (Grant, 2008), or caring approach (Gilligan, 1993) could be applied. Furthermore, the existing literature is primarily concerned with closed cycle solutions or CE in general, whereas CE studies on systemic solutions are less frequent. Research on larger systemic solutions is especially scarce due to a lack of implemented cases. However, their high significance for a CE (Ellen MacArthur Foundation, 2015) suggests to intensify research on the topic. Table 2 summarizes future research directions, structured along the seven overarching key topics.

This literature review makes a valuable theoretical contribution by

Table 2
Overarching key themes and future research directions.

Key Topics	Future Research Directions
External stakeholder collaboration required throughout the value chain (e.g., Aminoff and Pihlajamaa, 2020; Hazen et al., 2021; Konietzko et al., 2020; Pinheiro et al., 2019)	Who are relevant external stakeholders and how to collaborate with them to support CE implementation (e.g., by securing access to secondary raw materials); how to create shared assets within supply chains; how to set up CE-related co-creation and open innovation; to what extent the interplay between internal and external stakeholders influences CE implementation
Customers' perception to be shaped with communication (e.g., Ackermann et al., 2018; Singhal et al., 2019; Van Weelden et al., 2016; Wang and Hazen, 2016)	How consumers' perception differs between circular solutions, company types, industries; which communication levers such as transparency regarding recovery processes and pricing strategies can influence consumers' perception; how the COVID-19 pandemic influences the perception of sharing models; how community-based systemic solutions change customer identity; which role consumers play for the introduction of circular solutions; how incentives can motivate consumers to circular behavior; how customer relationships in a CE change through digitalization and customer interaction
Industry 4.0 supporting circular solutions (e.g., Chauhan et al., 2021; Cwiklicki and Wojnarowska, 2020; Lopes de Sousa Jabbour et al., 2018)	How Industry 4.0 technologies can support multiple product life cycles, customer retention, product traceability, and supply chain relations in a CE; which drivers, barriers, and prerequisites have to be regarded when applying Industry 4.0 technologies for CE implementation; how to shape and structure data repositories for PSS with Industry 4.0; how to establish a CE-specific architecture of an industrial internet
Performance measurement including non-financial metrics (e.g., Almagtome et al., 2020; Barnabè and Nazir, 2020; Hofmann and Jaeger-Erben, 2020; Svensson and Funck, 2019)	Which performance measurement systems are most suitable for a CE; how to measure the effectiveness of CE-specific performance indicators such as recycled content or utilization rate; how to evaluate product- vs. utility-related circular performance; how to support CE implementation with multi-criteria decision-making techniques
Multiple life cycle thinking required throughout the value chain (e.g., Ellen MacArthur Foundation, 2013; Farooque et al., 2019; Kazancoglu et al., 2020)	How to choose suitable methods and techniques for design for recovery, how to formalize industry-wide standards for design for recovery; how to solve the challenge of uncertain returns, interrelated with collection systems and recovery types; how to foster multiple life cycle thinking in cross-functional collaborations
CE-specific skills required throughout the value chain (e.g., De los Rios and Charnley, 2017; Sumter et al., 2020)	Which skill sets are required for different circular solutions and value chain categories; to what extent skills like systems thinking, multiple life cycle thinking, or collaboration can influence CE implementation and corporate culture; how to reflect the shift from material to performance focus and the shift from standalone to value chain orientation in employees' skill sets
Supportive top management and corporate culture as success factors (e.g., Chauhan et al., 2021; Hofmann and Jaeger-Erben, 2020; Kazancoglu et al., 2020)	How different steering models, leadership types, diversity, open innovation, and collaboration influence CE friendliness and implementation; to what extent CE implementation can influence corporate culture; how to use the CE as a catalyst for corporate transformation

challenging linear thought patterns in management research regarding circular solutions. The analysis of Porter's (1985) value chain framework in the context of CE literature reveals that its linear structure is not sufficient to reflect the CE perspective in a company. Therefore, a new circular value chain framework is developed that extends Porter's linear view to a circular business understanding. This review connects insights from management and CE research. It bridges the gap between CE literature and classical linear management research by diffusing circular thought patterns into established management approaches and providing suggestions on how to transform them into a circular business conception. This research is the first to give a detailed overview of CE implications for the whole value chain including primary and support activities. It also provides future research directions to enhance management research in a CE context.

As practical contribution, the review deepens managers' understanding of circularity at the firm level by investigating CE implications for a company's organizational processes. Findings reveal CE-related challenges for functional leadership and point at the necessity of new steering models with intra- and inter-organizational interfaces and the involvement of different management levels. In addition, the keyword validation of two industry experts allows this review to provide companies with a detailed practice-oriented view of stakeholders and change requirements for circularity and to guide them toward functional and cross-functional leadership responsibilities related to the CE.

The literature review is not without limitations. The literature search involved a restricted number of databases, search terms, and research areas and was oriented at Porter's (1985) value chain framework so that relevant articles might have been excluded. However, the selection of two highly CE-relevant databases, the usage of synonyms, and the inclusion of a CE-specific value chain category might have mitigated these limitations to a certain extent. Future research should extend the knowledge of CE implementation based on the findings of this review. Authors could investigate CE implementation in the context of other strategic management frameworks and examine the seven overarching key topics as well as CE effects on individual value chain categories in more detail. A variety of specific future research questions have been identified in this review, which open up new perspectives and aspects of a CE at the firm level.

6. Conclusion

This research reveals that the implementation of a CE affects nearly all of a company's value chain activities. The transition toward a CE creates cross-functional leadership responsibilities and requires a close collaboration with the external ecosystem. The way of working has to be adapted, incorporating multiple life cycle thinking and circularity in the employees' mindset. An analysis of CE implications along Porter's (1985) value chain framework shows that the linear structure of the framework is not sufficient to reflect circular business practices, requiring changes toward a circular and interconnected management view.

As the majority of companies worldwide embody a linear economic system along Porter's value chain, they face similar challenges when implementing circular solutions. The findings of this review address these challenges from a firm's management perspective and thus contribute new insights regarding CE implementation at a global scale. The review develops a new circular value chain perspective, which gains global relevance, by proposing changes to Porter's traditional management view. The high prioritization of the CE by governments shows its important role in achieving our climate targets and improving environmental sustainability. With a new managerial understanding of circular value chains and guidance for circular business practices this research supports companies on their way to implement circular solutions and to reduce resource-related CO_2 emissions as well as environmental pollution. Given the rising global importance of the CE and the eagerness of governments to support CE initiatives, companies will eventually have to decide how to deal with the CE. The better they are prepared to face the challenges of this new economic system, the easier a transition toward the CE can be achieved in the future.

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CRediT authorship contribution statement

Anja Eisenreich: Conceptualization, Methodology, Data curation, Writing – original draft, Visualization, Project administration. **Johann Füller:** Conceptualization, Writing – review & editing, Supervision. **Martin Stuchtey:** Conceptualization, Methodology. **Daniela Gimenez-Jimenez:** Writing – review & editing.

Declaration of competing interest

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

Data availability

No data was used for the research described in the article.

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