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From awareness to practice: Insights from the managers of Finnish circular economy pioneering companies

Binod Timilsina *, Phung Tieu Nguyen

University of Vaasa, Wolffintie 32, 65200, Vaasa, Finland

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ABSTRACT

In recent years, research on circular economy has increased tremendously, as well as gained attention from governments and business practitioners. However, the knowledge of effective and efficient transition from a linear business model to circular economy remains limited. Therefore, the objective of this research is to explore the awareness and current practices of managers from companies implementing circular business models. The required data for this research were collected from 22 managers, whose companies belong to the list of "41 pioneering Finnish circular economy companies". Methodologically, the study adopts a qualitative approach, following content analysis. The collected data is analyzed rigorously to uncover insights regarding managers' awareness to circular economy, experienced barriers, drivers, and indicators of circular economy. Key research results show that 66.7% of responses represent circular economy as a core activity, with 68% having already integrated circular economy principles into the supply chain. Main barriers include lack of knowledge and technology (21.4%), while strategies to address the barriers focus on promoting technology innovation (33.3%) and improving education and communication (31.3%). Besides, circular economy performance is measured primarily through recycled materials used (21.7%). Additionally, the study investigates the approaches companies employ to develop circular economy implementation strategies, an area often overlooked in circular economy literature. The findings indicate that process-led and market-led management strategies are commonly practiced, accounting for 32% and 21%, respectively. Overall, this study sheds light on the current state of circular economy implementation at the micro level and provides valuable insights for policymakers, practitioners, and researchers aiming to promote the transition towards a circular economy.

1. Introduction

Circular economy (CE) has garnered significant interest from academic researchers, business practitioners, and policymakers (Alcalde-Calonge et al., 2022; Cui and Zhang, 2018). One of the reasons for this attraction is that the world is seeking sustainable solutions to environmental, economic, and social problems, and CE has emerged as a promising concept. The academia has developed a variety of publications that align with this thought. For example, CE helps to reduce the amount of material used and diminish waste production (Provin et al., 2021; Rashid and Shahzad, 2021), CE is also recognized as a strategic choice to foster human development (Androniceanu et al., 2021), and it has become as one of the promising regulatory policies concerning sustainable development (Danish and Senjyu, 2023). Furthermore, CE is a path towards socio-economic sustainability (Mukherjee et al., 2023). In recent research Jin and Xu (2024a, 2024b) have emphasized the importance of accurate price forecasting in promoting resource efficiency, reducing waste, and optimizing the use of energy, which aligns with CE principles. In addition, various perspectives have been taken into consideration when studying the CE concept. For instance, researchers have focused on CE indicators (e.g. Geng et al., 2012; Moraga et al., 2019), targets (e.g. Morseletto, 2020), principles (e.g. Suárez-Eiroa et al., 2019), drivers and barriers (e.g. Giorgi et al., 2022; Kirchherr et al., 2018), strategies (e.g. Elia et al., 2017; Katsanakis et al., 2023), awareness (Gonella et al., 2023; Xue et al., 2010), and few more. Despite numerous studies, it remains unclear how company managers perceive the concept of CE, what barriers they identify, and what drivers, indicators, and management strategies they recommend or apply in CE practice.

Despite the widespread and rewarding advantages of CE, most companies still prefer a linear business model not only due to lower costs but also because they are unsure about how to integrate CE principles

* Corresponding author.
E-mail address: binod.timilsina@uwasa.fi (B. Timilsina).

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into their existing business establishments (Harmaala, 2021). In other words, as Tapaninaho and Heikkinen (2022) stated, businesses still have limited knowledge on how to adopt the CE model. To make a transition from a linear way of managing resources to a CE model, CE targets and principles must be carefully reviewed and put into action with greater coordination between different implementation levels (Suárez-Eiroa et al., 2019).

At the core, CE is a resource transition process in which natural resources are not exploited and wiped out in nature but are instead kept in the economy for the longest possible period (Johansson, 2021). Nevertheless, such a process does not appear to be entirely feasible in practice (Potting et al., 2017). According to Corvellec et al. (2022), CE has shown several limitations and unclear theoretical foundations, and its implementation suffers from structural challenges. Europe is often cited as a pioneer in the transition to CE; however, the foundations, practicality, and consequences of its circular business models are widely questioned (Corvellec et al., 2022). Furthermore, more than 200 definitions of CE were discovered in the literature (Kirchherr et al., 2023). This indicates that there is not a shared understanding of CE, i.e. the meaning of CE is different for different people (Anastasiades et al., 2020).

Based on the gaps and issues outlined above, it is reasonable to assume that there is a need to understand how company managers perceive the circular economy concept, its challenges, and best practices. Therefore, the research attempts to address the following questions.

- RQ1. How do managers perceive the concept of CE in terms of its principles, implications for business operations, and relationship to sustainability?
- RQ2. What are the barriers to CE implementation and what recommendations do managers have to assist policymakers in enhancing CE practices?
- RQ3. What are the drivers, indicators, and management approaches for the development of CE implementation strategies?

By answering these research questions this study aims to meet the following objectives.

— Identify if managers' awareness of CE and its concepts influences the transition to CE,
— Determine barriers, drivers, indicators, and management approaches for developing CE implementation strategies, and
— Propose recommendations for stakeholders and policymakers to enhance CE practices.

This research will contribute to the CE literature as one of the pioneering studies that explore managers' perceptions to CE. Furthermore, the novelty of this research lies in its focus on management approaches for developing CE implementation strategies, an area that remains underexplored in CE literature. By analyzing the experiences of managers from pioneering Finnish CE companies, the study uncovers valuable insights into the barriers, drivers, and strategies that are commonly practiced in transitioning to a circular business model. The findings of this research could be useful for policymakers, practitioners, and researchers, offering practical guidance to support and facilitate the shift toward circular business practices.

2. Literature review

2.1. Definitions and principles of circular economy

The exponential growth of research on CE recently has led to some ambiguity in its definitions (Schöggl et al., 2020). CE is defined linguistically as a term that has the opposite meaning of linear economy (Murray et al., 2017). In a linear economy, the products that are manufactured by utilizing virgin materials extracted from natural resources are burned or disposed of in landfills after use (Potting et al., 2017); therefore, a large amount of waste is generated, which harms the environment and makes resources scarce (Lahane et al., 2021). In a CE model, on the contrary, resources are continuously circulated throughout the whole supply chain (Gonella et al., 2023), with the engagement of all stakeholders, for the purpose of minimizing environmental impact, encouraging sustainable economic development, and creating social equity (Kirchherr et al., 2023). It is implemented at three economic levels: micro (products, companies, consumers), meso (eco-industrial parks), and macro (cities, provinces, regions, nations) (Bleischwitz et al., 2022; Merli et al., 2018). CE core principles are addressed and explained with variations of the R framework, such as 3Rs, 4Rs, 6Rs (Reike et al., 2018), or even 9Rs (Potting et al., 2017). While the 3Rs, which includes Reduce, Reuse, and Recycle, is considered the most fundamental (Ghisellini et al., 2016; Ranta et al., 2018) and is at the core of the CE promotion law of China (Ghisellini et al., 2016), the 4Rs with the addition of Recover is arguably the most embedded CE model and is at the heart of the European Union Waste Framework Directive (Anastasiades et al., 2020).

2.2. Barriers and drivers of circular economy implementation

While the benefits of CE are becoming more widely acknowledged, the transition to CE requires consideration of some external and internal factors (Dey et al., 2020). Thus far, many studies have investigated the barriers, risks, opportunities, and drivers of CE implementation (e.g. de Jesus and Mendonça, 2018; Giorgi et al., 2022; Ranta et al., 2018). Barriers and drivers are generally categorized into two groups: internal and external (Manoharan et al., 2022). Nevertheless, considering CE practice, Ranta et al. (2018) studied companies in Europe, the US, and China, and divided the barriers and enablers into three major groups, including regulatory, normative, and cultural-cognitive. During the same period, de Jesus and Mendonça (2018) conducted research on the Eco-innovation path to CE and listed four main groups of challenges and drivers, namely technical, economic, institutional, and social. Not long after, while Tura et al. (2019) presented a seven-dimensional framework to unlock CE, Rizos et al. (2021) created a six-factor portfolio for electric and electronic equipment and agri-food firms. More recently, in the study of CE implementation in the building industry, Munaro and Tavares (2023) developed five primary groups of barriers and key drivers: economic, informational, institutional, political, and technological.

2.3. Indicators for measuring circular economy

The transition to CE requires stakeholders to have the skills to monitor and measure circularity through indicator-based frameworks (Kristensen and Mosgaard, 2020). The term 'indicators' is explained in the literature in several ways (Joung et al., 2013), but they are in general seen as an effective tool for uncovering and simplifying complex information and measuring progress and performance (Saidani et al., 2019). Indicators used to measure CE vary depending on the economic levels (Papageorgiou et al., 2021). Regarding the micro level, Linder et al. (2017) evaluated five indicators employed to measure product circularity, while Kristensen and Mosgaard (2020) analyzed 30 indicators and stated that the majority of them relate to recycling and fall into the economic aspect of the three dimensions of sustainability (environmental, economic and social). Nevertheless, in recent research, Vinante et al. (2021) showed that most indicators at the micro level belong to the environmental dimension. There are also studies reviewing the indicators applied at all three economic levels (e.g. De Pascale et al., 2021; Elia et al., 2017; Pauliuk, 2018). The study by De Pascale et al. (2021), examining 61 indicators, highlighted that a large portion of indicators are connected to the environmental and economic aspects of sustainability. Besides, life cycle assessment (LCA), known as "the state-of-the-art tool" for evaluating a product's effects on the

environment throughout its life (Nwodo and Anumba, 2019), has been considered a key factor in environmental policy in many countries (Guinée et al., 2011).

2.4. Circular economy and sustainability

Sustainability is considered top of the agenda by policymakers and a crucial point in business strategies (Geissdoerfer et al., 2017). A common understanding of sustainability is the "triple-bottom line" (Elkington, 1998) which stands for striking a balance between society, the environment, and the economy (Kristensen and Mosgaard, 2020). Numerous studies have examined the relationship between CE and sustainability (e.g. Millar et al., 2019; Suárez-Eiroa et al., 2019).

Although opinions on this relationship vary, it is undeniable that CE and sustainability are closely connected (Kristensen and Mosgaard, 2020). The difference between them is perhaps in the nature of the relationship (Kristensen and Mosgaard, 2020), for example, Geissdoerfer et al. (2017) stated that CE is a prerequisite for sustainability, Suárez-Eiroa et al. (2019) concluded that CE is beneficial for achieving sustainability. CE helps to push businesses and organizations toward more sustainable practices in a number of areas, including research and development, logistics and reverse logistics, quality control, environmental management, cost management, service management, and strategic planning (Barros et al., 2021).

2.5. Management approaches for developing CE strategies

Changing to a new business model is considered a basic way to encourage innovation for sustainable development (Evans et al., 2017), but it also requires knowledge and experience of managers in building implementation strategies and choosing management approaches that are appropriate to the company's culture, the personalities of the executives and the business environment. Among management approaches, top-down and bottom-up are most mentioned in academic research (e.g. Gotsch et al., 2023; Heyden et al., 2017; Mom et al., 2007). Under top-down management, knowledge flows down the hierarchy from the top management level (Mom et al., 2007), i.e. decisions are made at the top and then communicated down the chain of command. With bottom-up management, on the other hand, knowledge moves up the hierarchy from people at lower levels (Mom et al., 2007), i.e. employees from all levels are involved in decision-making and strategic planning. In addition to these two methods, process orientation, process-led, and market orientation are also preferably used in business management. While the market-oriented approach prioritizes value creation for consumers (Narver et al., 1998), the process-oriented approach focuses on optimizing core business processes (Willaert et al., 2007). Similarly, a process-led approach emphasizes the active use of process models to facilitate strategic change within organizations, concentrating on the effective implementation of processes rather than merely designing new processes (Bainbridge, 1996). It is important to note the difference between process-oriented and process-led approaches. The key difference lies in their focus. In a process-led approach, decisions and actions are driven by the established steps and rules of the process, meaning that the process itself guides decision-making. In contrast, a process-oriented approach seeks to improve and optimize process steps and rules, where decisions and actions are directed toward enhancing process efficiency and effectiveness. The mentioned approaches appear to be important in management; however, to the best of our knowledge, there is little known about the management approaches followed by CE practitioners, for example, which management approaches are preferred by businesses in developing CE implementation strategies. In fact, top-down and bottom-up management approaches have been discussed in the CE literature, but only concerning the measurement of product circularity, or a little more broadly, the link between macro and micro economic levels in proposing CE implementation strategies (e.g. Lieder and Rashid, 2016; Saidani et al., 2017). The transition to CE is a complex process, which requires a proper management approach to reduce the risks associated with the transition. In this context, our study aims to explore management approaches practiced by CE pioneering companies' in developing CE implementation strategies.

2.6. The role of company managers' perception and awareness of circular economy

Perception is known as "the cognitive process of selecting, organizing, storing, and interpreting information obtained by five human senses" (Rótolo et al., 2022). Several studies have been carried out regarding people's awareness and perception of CE (e.g. Gonella et al., 2023; Guo et al., 2017; Rótolo et al., 2022; Xue et al., 2010). Among them, people's level of perception is said to be one of the key drivers for the shift to a CE (Gonella et al., 2023). Despite growing attention, research on the perception and awareness of CE transition is more relevant to officials, the public, or students (e.g. Bigerna et al., 2021; Liu et al., 2009; Xue et al., 2010) than company managers. Research by Liu and Bai (2014) looked for company managers' awareness of CE; however, the purpose is to examine the connection between companies' awareness and behavior in implementing CE. Although there is limited evidence regarding the role of company managers' perception and awareness of CE in the transition, Koistinen et al. (2022) emphasized that top managers play a critical role in implementing the CE, i.e. company managers act as "a microfoundation of the CE transition".

3. Methodologies

This study adopts a qualitative research design, specifically an exploratory approach, to examine how managers perceive the concept of CE and how it is understood and implemented at the micro level. To commence the research, we conducted a literature review to build the foundation for the study. During the process of background research, we realized that a combination of multiple-choice questions supported by open-ended questions would be more appropriate for the study. We are particularly interested in understanding the managers' awareness of the concept of CE, as well as the challenges and best practices associated with transitioning to CE. The assumption behind multiple choice questions is that we can incorporate as many questions as possible to measure the awareness of the respondents regarding the research topic. Similarly, the assumption behind the open-ended questions is that the respondents have the opportunity to express their opinions on the subject freely, which may help them to highlight issues that are important but not covered by multiple-choice questions. For these reasons, survey questions in this study include both multiple-choice and open-ended questions.

The survey was compiled in Finnish and sent to managers of Finnish companies via email. With the research scope being companies pursuing circular business models, the study considered a purposeful sample consisting of "41 pioneering Finnish circular economy companies", a list compiled by Sitra - Finnish Innovation Fund. The primary reason for selecting these companies for the study is Finland's recognition as a pioneer in the transition to CE and has established the first national CE roadmap since 2016 (Järvinen and Sinervo, 2020). In total 22 respondents participated in the survey.

For analysis, the survey results were translated from Finnish to English. The data were analyzed in an exploratory manner, supported with descriptive values such as percentages. Additionally, the data from open-ended questions were analyzed and interpreted using content analysis. Content analysis is a method of reducing phenomena and events by placing them into categories for better analysis and interpretation (Harwood and Garry, 2003). Accordingly, the data were classified and grouped into coding units based on content similarity, then aggregated into tables that include the percentage of times the coding units appear. To establish reliability and validity, initially, the data were

analyzed and interpreted separately by the authors, and then the results of the individual analyses were brought together for discussion to find a common agreement.

4. Results

4.1. The profile of respondents

The aggregated information of the 22 respondents and their companies is shown in Table 1. The sample size may sound a bit small but represents managers from the list of "41 pioneering Finnish circular economy companies", a good fit considering the scope of this study. As can be seen in Table 1, the respondents hold various management positions in their companies. More than half of them are CE experts (59.1%) and the rest are individuals with some experience in CE (27.3%). Regarding the scale and type of business, the majority of the companies that the respondents work for are micro, small and medium enterprises (SMEs) (77.3%), and are part of the industries that use raw materials provided by the primary sector (63.6%). In terms of financial situation, a substantial portion of companies have not encountered difficulties in the last few years (77.2%) and are not currently facing serious financial problems (90.9%). The managers are even quite optimistic about their companies' future growth as they all believe that their companies' profits will stabilize or improve over the next few years.

4.2. Managers' perception and awareness to circular economy

As shown in Table 2, the respondents have different perspectives on CE. Namely, some respondents linked the CE model to "*the way of life and personal* agenda" or "*the future*", or even "*a return to the roots*", others

Table 1
Basic information about the survey respondents and their companies.

		Responses	Percentage
Respondents	Respondents' positions	Chief executive officer	13.6
		Operational manager	13.6
		Technology manager	13.6
		Marketing manager	4.5
		Business development manager	4.5
		Department head	4.5
		Supervisor	4.5
		Others	40.9
	Respondents' experience with circular economy	A circular economy expert	59.1
		A person with some experience in circular economy	27.3
		A novice	13.6
Companies	Business size	Micro	27.3
		Small	36.4
		Medium	13.6
		Large	22.7
	Business type	Primary	13.6
		Secondary	63.6
		Tertiary	22.7
	Current financial situation	Weak	9.1
		Fair	4.5
		Satisfactory	22.7
		Good	40.9
		Excellent	22.7
	Financial changes over the past few years	Weakened significantly	4.5
		Weakened slightly	18.2
		Not changed	31.8
		Improved slightly	22.7
		Improved significantly	22.7
	Financial changes over the next few years	Not changed	13.6
		Improved slightly	36.4
		Improved significantly	50

Note: The percentages in Table 1 are calculated based on the number of responses divided by the total number of survey participants, which is 22.

Table 2
Managers' perceptions of the circular economy in terms of its meaning, connection to sustainability, principles, and integration into the supply chain.

	Total obtained responses	Responses	Percentage
What is circular economy from your perspective?	21	A return to the roots	9.5
		A sustainable consuming choice	9.5
		Something good but hard to achieve	4.8
		Something important for work and life	14.3
		The consumption of used goods	4.8
		The efficient use of resources	14.3
		The future	9.5
		The reuse of resources	14.3
		The waste sorting	9.5
		The way of life	9.5
What does circular economy mean for your company?	21	The core activity	66.7
		One of key factors	23.8
		The future of the company	4.8
		An opportunity to run a business	4.8
Why is circular economy important for your company?	21	It is the core business	52.4
		It enables efficient utilization of resources	14.3
		It brings green values	14.3
		It creates new business opportunities	9.5
		It is the foundation of everything	9.5
What is the difference between circular economy and sustainability?	19	Circular economy is a part of sustainability	52.6
		Different purpose	26.3
		Different way of thinking	10.5
		Different time span	5.3
		Sustainability supports circular economy	5.3
Which best describes the circular economy principles?	22	Refuse	4.5
		Reduce	9.1
		Reuse	9.1
		Repair	13.6
		Refurbish	4.5
		Recycle	27.3
		Rethink	0
		Repurpose	0
		Recover	0
		Others	4.5
		All of the mentioned Rs	27.3
Should circular economy principles be incorporated throughout the supply chain?	22	Yes	100
Have circular economy principles been incorporated throughout the supply chain of your company?	22	Yes	68
		No	32

Note: The percentages in Table 2 are calculated based on the frequency of each response mentioned, relative to the total number of obtained responses, not the number of respondents. Each respondent could provide multiple responses to a question or, in some cases, no response at all. Consequently, the total number of obtained responses varies by section and question.

more specifically connected it to the production and consumption aspects, such as "*the reuse of raw materials*" or "*a longer life cycle of products*" or "*the waste sorting"*. Several respondents vaguely defined CE as "*something good but hard to achieve*", or something "*important both for work and in everyday life*". Nevertheless, it is noteworthy that considering CE as *"a core activity"* accounts for the largest number of responses (67%) when the respondents were asked to reflect on the significance of CE to their companies. Besides, some respondents emphasized the important role of CE in their business operations and claimed that CE "*is chosen as part of the development of sustainability*", or "*is a part of doing business*". Giving reasons why CE is important, one respondent, who stated CE is their company's core activity, asserted that "*without CE we do not have a business*". Other explanations worth mentioning are that "*CE is the only way to exist in the future*", or "*CE is a megatrend creating new value and business opportunities for our stakeholders. It is important that we stay at the forefront of the CE in our industry so that we can operate as a more sustainable alternative to linear disposables*". Regarding principles, it can be seen that recycling and the combination of all Rs included in the survey account for the largest and equal proportion (27%). Other single principles such as refuse, reduce, reuse, and repair are also considered to best describe CE principles, but in small proportions. In all respondents' opinions, the principles of CE should be incorporated throughout the supply chain; however, only 68% respondents stated that their companies have already incorporated CE principles throughout the supply chain.

In terms of the relationship between CE and sustainability, it is visible that more than half of the responses are "*CE is a part of sustainability*" (52.6%). Regarding this, one respondent highlighted "*sustainability is diversity that avoids overconsumption. The circular economy plays a big role in that, because economic growth does not depend on the consumption of natural resources*". Contrary to the idea that CE is part of sustainability, some respondents argued that CE and sustainability are different in purpose, specifically "*circular economy tries to fix a system that produces waste, while sustainability takes the total use of the materials into account from the very beginning, i.e. no waste is generated"*, or simply put, "*in a circular economy, ways are developed to reuse waste. In sustainability, the goal is to develop new things that are required so that they do not burden nature as much as before*". The main difference between CE and sustainability is highlighted as "*way of thinking*" and "*time span (*referring to now it is the time to implement circular economy principles in practice i.e. we are moving towards the circular economy era*)*" are also pointed out by the respondents. On the whole, it can be said that most managers perceived CE and sustainability to be closely related.

4.3. Internal and external barriers to circular economy and their mitigation

Table 3 shows that the number of external barriers pointed out by respondents is greater than the number of internal barriers. In regard to internal barriers, rigid structure, lack of resources, and lack of knowledge and technology are indicated at the same highest rate (21%). Concerning these, one respondent highlighted that "*there is internal resistance in large companies, and some want to act as they have always acted before*". Another said, "*the necessary raw materials are not available in all respects in accordance with the circular economy, or if they are, their quality or technical functionality is not sufficient*". Besides, "*costs and time of new operating models*" are also of concern, since "*the implementation of circular economy increases delivery times, brings more costs if the volumes are small*". Notwithstanding, some respondents stated that there are "*not many*" or even "*no internal barriers*" when implementing CE, and these ideas account for 14.3%. To overcome the obstacles, a number of managers suggested increasing investments in technology and promoting business innovation. These two suggestions account for the largest proportion (33.3%) and are consistent with the barriers caused by the rigid mindset and the limitation in technology as mentioned above. In addition, there are some ideas for separating CE from the old-fashioned models.

Table 3
Barriers to circular economy and their mitigation.

	Total obtained responses	Responses	Percentage
Internal barriers	14	High process costing	14.3
		Lack of resources	21.4
		Rigid structure	21.4
		Lack of knowledge and technology	21.4
		Long delivery lead time	7.1
		Few or no barriers	14.3
Internal barriers mitigation	6	Increase investments in technology	33.3
		Promote business innovation	33.3
		Separate the circular economy from linear model	16.7
		Be willing to adapt new things	16.7
External barriers	26	Legal restrictions	19.2
		Lack of waste collection points	3.8
		Poor agricultural conditions	3.8
		Price competition	15.4
		Consumption habits	11.5
		Different starting points in countries	3.8
		Lack of rewards	3.8
		Lack of measurement system	3.8
		Lack of long-term policies	7.7
		Lack of practical action plans	3.8
		Lack of financial support and control	7.7
		High value-added tax	11.5
		Lack of the awareness of civil servants and politicians	3.8
External barriers mitigation	32	Improve education and communication	31.3
		Amend the legislation	15.6
		Increase financial support from public sector	12.5
		Reform tax policy	9.4
		Provide fact-based research reports	9.4
		Issue state-level recommendations	3.1
		Promote the value of circular economy materials	9.4
		Facilitate the recycling process	9.4
Who plays a major role in implementing CE?	26	All people	19.2
		Decision makers	26.9
		Government	15.4
		Retail industry	3.8
		Companies	11.5
		Market	3.8
		Consumers	11.5
		Innovators	3.8
		Political influencers	3.8

Note: The percentages in Table 3 are calculated based on the frequency of each response mentioned, relative to the total number of obtained responses, not the number of respondents. Each respondent could provide multiple responses to a question or, in some cases, no response at all. Consequently, the total number of obtained responses varies by section and question.

In terms of external barriers, Table 3 shows that legal restrictions are mentioned the most (19.2%), followed by price competition (15.4%). According to some managers, companies striving to achieve CE are

experiencing "*the slowness of legislative changes*" and facing competition with other companies that produce "*cheap goods*". Other than these, several managers also emphasized that "*too high value-added tax is charged for circular economy products*", and on the consumption side "*customers have been very slow to make changes until now*". An important issue to note is the "*lack of* financial support *and control*", which significantly affects companies' willingness to make changes because every business needs profits to maintain operations. Besides, in the respondents' eyes, the transition to CE also has shortcomings in rewards, measurement systems, long-term and practical policies, sustainable agriculture, waste collection points, and even the awareness of civil servants and politicians. Furthermore, the different starting points between countries in the transition to CE are also said to cause difficulties. To overcome such barriers, the respondents offered a variety of ideas (see Table 3). Concerning the barriers caused by taxes, a manager suggested that "*the taxation of new and used goods should be differentiated from each other, the idea of taxing both at the same tax rate is a completely poor idea*". Regarding financial-related problems, one of the respondents emphasized "*financial profitability is a prerequisite for promoting circular economy practices on a larger scale. If we want to disrupt existing business models, we need carrots to promote the profitability of companies practicing circular economy practices, as well as direct* financial support *for pioneering companies in the early stages of maturity*". And what's more, as recycling is considered the most preferred principle, policymakers should "*make recycling as easy and affordable as possible*" and provide "*more information for consumers about the rationality of recycling, where the recycled materials end up, what is done with them*". But the reality is, a new model cannot be adapted without knowledge and willingness to change. Therefore, the respondents also recommended the increase in "*education and communication among stakeholders*", which accounts for the highest rate (31.3%) among the recommendations. To put these solutions into practice, it is necessary to clearly define the roles of stakeholders. When asked who plays the main role in CE implementation, 26.9% of the responses are decision-makers, followed by all citizens (19.2%) and the government (15.4 %). The stakeholders with fewer votes are companies, consumers, political influencers, the retail industry, the market, and innovators. For clarification, in the traditional view, stakeholders are those whose support is crucial for an organization's existence. In the context of this paper, stakeholders are defined as individuals or groups that have an interest in or have an ability to influence circular economy practices. Thus, stakeholders are not limited to those essential for an organization's survival but encompass any party with a significant interest in the successful implementation of the circular economy.

4.4. Drivers, indicators, and management strategies

Concerning main drivers, the respondents appear to appreciate the importance of citizens' awareness, efficient use of materials, technological innovation, and the role of companies, accounting for 20%, 20%, 16%, and 16% of the drivers respectively, see Table 4. Additionally, some managers suggested a combination of different key drivers instead of a single one, which suggests that in some cases the drivers need to come together. For instance, *"technology development"* should be accompanied by *"government investment"*. Although the companies are perceived to be competing on price with those operating under a traditional linear model, as mentioned in section 4.3, competitiveness accounts for only a small proportion (4%) of the key drivers in the transition to a CE. Surprisingly, greenhouse gas (GHG) emissions are the only environmental factor considered as a driver of the circular economy, accounting for just 4%.

It can be seen from Table 4 that among the circular economy indicators proposed by the respondents, the percentage of recycled material used accounts for the largest portion at 21.7%, followed by the amount of waste generated at 13%. This makes better sense because when asked 'Which best describes the circular economy principles?', most respondents emphasized recycling as a core principle of the circular economy, see Table 2. The life cycle assessment, on the other hand, only accounts for 8.7%. Additionally, the list of indicators includes "*the number of patents*", used to measure CE. Although this indicator is not related to the production of secondary materials nor directly affects circularity, it demonstrates the development of knowledge and technology in this field. Overall, it can be concluded that the indicators mainly relate to the environmental aspect, none of them appears to be concerned with functions such as product sharing.

Regarding management approaches for developing CE implementation strategies, Table 5 shows that process-led accounts for the largest

Table 4
Drivers and indicators for circular economy.

	Total obtained responses	Responses	Percentage
Drivers	25	Citizens' awareness	20
		Efficient use of materials	20
		Government investment	8
		Competitiveness	4
		Companies	16
		Technological innovations	16
		Consumption reduction	4
		GHG emissions	4
		Cost efficiency	8
Indicators	23	Life cycle assessment	8.7
		GHG emissions	4.3
		The amount of raw material used	8.7
		The percentage of recycled material used	21.7
		The amount of waste	13
		The percentage of residual products	4.3
		The number of patents in the field	4.3
		The amount of e-waste (WEEE)	4.3
		Carbon handprint	8.7
		The number of second-hand markets	4.3
		Material flow analysis	4.3
		The percentage of business operations	4.3
		The CO2 emissions	8.7

Note: The percentages in Table 4 are calculated based on the frequency of each response mentioned, relative to the total number of obtained responses, not the number of respondents. Each respondent could provide multiple responses to a question or, in some cases, no response at all. Consequently, the total number of obtained responses varies by section and question.

Table 5
Management approaches for developing circular economy implementation strategies.

	Total obtained responses	Responses	Percentage
Single approaches	19	Process-led 32%	32
		Market-led 21%	21
		Top down 0%	0
		Bottom up 0%	0
		Social welfare-led 5%	5
		Partnership-led 5%	5
Combined approaches	19	Process-led and Market-led 21%	21
		Process-led and Top-down 5%	5
		Top-down and Bottom-up 11%	11
		Market-led and Bottom-up 5%	5

Note: The percentages in Table 5 are calculated based on the frequency of each response mentioned, relative to the total number of obtained responses, not the number of respondents. Each respondent could provide multiple responses to a question or, in some cases, no response at all. Consequently, the total number of obtained responses varies by section and question.

share (32%). This approach is also adopted in combination with market-led (16%) or top-down (5%). Regarding the process-led approach, one of the respondents pointed out, "*when we think about the production process and take off everything unnecessary, both cost and environmental benefits are obtained*". Here, a process-led approach means the decisions and actions are guided by the steps and rules of the process. The aim is to reduce waste, improve resource efficiency, and adopt more sustainable practices. Besides this fact, some companies apply the market-oriented management approach (21%), of which one emphasized the role of "*market- and value-orientation and the added value of circular economy in business*" in developing CE implementation strategies. Another noteworthy approach mentioned is the joining of top-down and bottom-up (11%), in which "*the push comes from the top, but at the same time, every level is encouraged to think about how things could be done better and with less burden on the environment*". Surprisingly, none of the respondents claimed to practice top-down and bottom-up approaches separately, instead, they preferred these approaches in combination with each other and other approaches, see Table 5. In addition, several companies also expressed orientations towards social welfare and partnership, but at a low rate. Thus, it is reasonable to claim that there is diversity in the managerial approaches that the companies are applying. However, it remains unclear to what extent these approaches contribute to the implementation of CE strategies in practice.

5. Discussions

5.1. The obtained results

In terms of the background of the respondents and their companies, the diversity in job positions might lead to different perspectives on an issue, specifically the concept of CE in this study. However, the large number of CE experts participating in the survey gives a big plus for achieving research reliability, as Chouinard et al. (2019) highlighted that expert knowledge and judgment are the most commonly used decision support techniques across industries. In addition, the high participation of SMEs provides valuable insights into our research as SMEs arguably play the most major role in CE transition process (Ormazabal et al., 2018), and they account for 99% of businesses in the EU (Filipe et al., 2016). Notwithstanding, more than half of the companies belong to the secondary industry, see Tables 1 and ie they rely on the primary sector for raw resources for production, as a result, they might find it challenging to quantify the environmental impact of their operations. Nevertheless, it is worth noticing that the companies have still maintained or even improved their business performance so far, see Table 1, even though the outbreak of Covid-19 has had a huge impact on the worldwide economy, affecting the activities of businesses and governments and the connection between people and nature (Santolin et al., 2023). This suggests that the circular business model may have begun to take effect in these companies.

In regard to managers' perception to CE, despite the small sample size, it becomes apparent that CE is understood and interpreted in many different ways, even some ways that sound vague and general, see Table 2. However, this diversity in understanding and interpretation appears to be normal because, according to Dahlsrud (2008), stakeholders often have difficulty providing particularly thoughtful feedback when being asked to examine the understanding of a concept. Nevertheless, these differences also raise concerns about the effectiveness of transmitting national CE policies to the microeconomic level. Despite large-scale CE plans and policies being developed and the growing number of companies actively striving for CE, the concept itself remains fragmented in the eyes of business practitioners. Regarding the principles, most of the managers participating in the survey choose recycling as a core principle of CE, see Table 2. Although recycling is the most widely utilized strategy (Kirchherr et al., 2017), Moraga et al. (2019) highlighted that only a small amount of waste collected for recycling is actually recycled, raising questions about the value of such materials and the effectiveness of current recycling processes. In addition, Potting et al. (2018) emphasized that recycling might require more energy at times than creating new materials and recycling old materials is usually not the best idea because they may include chemicals that are harmful to the environment and people. Recycling is obviously important; however, we argue that it is also necessary to make sure that materials and products are made with the intention of being reused, repaired, and remanufactured from the beginning as recycling might lead to carbon emission. In addition to recycling, the combination of the 9Rs mentioned in section 4.2 is also the most preferred when it comes to CE principles. Concerning the relationship between CE and sustainability, most of the managers are in the same thoughts as scholars that there is a close connection between these two terms, see Table 2. Nevertheless, in reality, it is hard to measure how deep the connection between CE and sustainability is (Daglis et al., 2023).

With reference to barriers and their mitigation, our study does not specifically list barriers and solutions in pairs but only lists them into groups of internal and external factors, see Table 3. Among them, those related to legislation, costs, financial resources, innovation, education, and communication are worth discussing as they have been densely repeated in literature (e.g. de Jesus and Mendonça, 2018; Rizos et al., 2021). As most of the companies are SMEs, they might be heavily affected by legislation and competition, and as (Rizos et al., 2021) claimed, it is also quite difficult for SMEs to secure the funding required to expand CE activities. In addition, although managers believe that their companies are in a good financial situation and are optimistic about future performance, as shown in section 4.1, it is worth bringing financial resources to the attention, because a new business model requires investment in technology and innovation, and according to Meili and Stucki (2023), "financial resources are important for both beginners and leaders in the circular economy". Besides, we argue that policymakers should pay attention to technology as well as cooperation in technology development when implementing CE. As Truant et al. (2024) pointed out, technology aids in converting CE concept into practical actions, helps companies operate more sustainably by forecasting product demand and quantities, as well as improving inventory management systems. We also argue that proposals only become practical solutions when there is a knowledge exchange and collaboration of all stakeholders at multiple economic levels. Otherwise, CE continues to be perceived and implemented differently among stakeholders, leading to getting stuck in bringing CE to fruition.

With regard to key drivers, although they are not classified into groups, their content is to some extent consistent with the results of previous research on CE drivers (e.g. Munaro and Tavares (2023); Tura et al. (2019), which also emphasizes the importance of technologies and people's awareness, see Table 4. Nonetheless, it is noteworthy that managers did not mention information sharing and collaboration as a key driver, while Tura et al. (2019) emphasized that reducing obstacles to CE requires collaborative efforts and the exchange of information and resources between government, industry, and academia. Concerning the indicators, most of the indicators proposed by the respondents focus on waste and materials and also relate to the environmental aspect, see Table 4. On the contrary, according to a study conducted by Kristensen and Mosgaard (2020), most CE indicators are related to economic dimension, followed by environmental and social dimensions to a lesser degree. We argue that although CE is frequently mentioned in connection with reducing greenhouse emissions, the economic aspect, e.g. "value of remanufactured product/parts, or the cost to disassemble a product" (see Kristensen & Mosgaard (2020) for more indicators) needs to be focused and measured. This is simply because a business model that makes it difficult to make a profit will reduce the willingness and enthusiasm of business practitioners and stakeholders to some extent. Furthermore, it is also critical to catch sight of and identify potential social outcomes of the transition to have a deeper comprehension of the possible trade-offs among all three elements of sustainability (Pitkänen et al., 2023). In terms of managerial approaches for developing

strategies for CE implementation, process-led is mentioned the most by respondents, but not very dominant compared to others, see Table 5. As mentioned in the literature section, this concept has not been explored in CE studies, we find it challenging to evaluate whether such management approaches are effective. However, a positive point worth noting is that companies have a stable business situation and managers have confidence in the company's development in the next few years, while the world has been going through a difficult time caused by the Covid-19 pandemic as well as the war in Ukraine. This can be attributed to the company's management approaches to developing strategies.

5.2. The contribution, limitation, and future research

Our research offers notable contributions to both academia and managerial practices, particularly in advancing the implementation of circular economy principles. Academically, it stands as one of the pioneering studies exploring company managers' perceptions to CE, extending prior research that has mostly concentrated on consumers, students, and firms, as mentioned in section 2.6. This focus on managerial approaches to CE implementation fills an important gap in the literature by shedding light on how companies develop strategies to transition toward CE practices. This understanding is crucial, as it demonstrates the need for an effective management system that can support the successful adoption of CE while driving business performance.

Furthermore, from a practical perspective, our findings offer valuable insights for policymakers seeking to understand the micro-level dynamics of CE within companies. Indeed, the findings and results of this study offer valuable insight for policymakers to assess the effectiveness and limitations of current policies and programs related to CE. These insights may support the development of more refined and impactful strategies, promoting a smoother transition toward a sustainable and circular business model.

Notwithstanding, there are certain limitations on the scope of the study. The most significant limitation is the modest number of respondents and localized samples. The small and localized sample may restrict the diversity of experiences and limit the generalizability of the findings. Therefore, further studies with a larger sample size should be conducted to compare, generalize, and confirm the findings and results of our study. Additionally, our study specifically focuses on investigating managers' perceptions to CE within companies that are actively engaged in CE practices. While these companies are critical to understanding the challenges and success factors of the CE transition, future research is recommended to consider companies that have not embraced or even those who oppose the CE model. This consideration in future research may provide a more comprehensive view of the barriers, drivers, indicators, potential strategies, and management practices for the wider adoption of CE principles. Similarly, future research may extend this study in different geographic and cultural contexts and even conduct cross-industry comparisons. Longitudinal studies or case studies may also provide deeper insights into the evolution of managerial perceptions and practices over time. Additionally, as our research was conducted in Finland, readers should proceed with caution when generalizing or trying to adapt the results in another context.

6. Conclusion

The main objective of this study was to explore managers' perceptions towards CE, with the research scope being Finland, a pioneer in the transition to CE, with the aim of determining how managers perceive the concept of CE, what barriers the companies face, what they recommend to do to overcome barriers, and what drivers, indicators and management approaches support CE practices. The literature review and the findings gave fundamental insights into the mentioned research issues. Regarding RQ1, it can be concluded that managers have diverse understanding and interpretation of CE. However, all managers confirm the significant implication of CE to their business. In addition, recycling and the integration of 9 Rs are the most preferred principles, and sustainability is said to have a close relationship to CE. Furthermore, decision-makers, governments, and all citizens are seen to play an important role in bringing CE into practice. Regarding RQ2, the study found that the number of external barriers mentioned was greater than the number of internal barriers. Among the barriers identified, high process costs, legal constraints, lack of education, lack of technological innovation, and financial resources were of most concern. Accordingly, many managers believed that increased education, technological innovation, and legal adjustments could help to reduce barriers. Additionally, from our perspective, we suggest that emphasis should be placed on knowledge exchange and cooperation during CE implementation to eliminate existing bottlenecks. Regarding RQ3, the study found that people's awareness, efficient use of materials, technological innovation, and companies are the key drivers of CE implementation. Furthermore, most of the proposed indicators are direct indicators focusing on waste and materials. In terms of management methods, process orientation is the most preferred, followed by market orientation. From these findings, we believe that this research provides valuable insights for researchers and practitioners interested in understanding and implementing CE. Thus, making it not a story about theory or perception but a story about practical and sustainable actions in the context of CE.

As discussed in section 5.2, the main limitation of this study lies in its limited and localized sample, which affects the diversity of managers perspectives to CE practices and generalizability of the findings. Therefore, future research should include a broader range of companies, geographical locations, and explore additional context to provide a more comprehensive understanding of CE practices and adoption.

CRediT authorship contribution statement

Binod Timilsina: Writing – review & editing, Writing – original draft, Supervision, Methodology, Formal analysis, Data curation, Conceptualization. **Phung Tieu Nguyen:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation.

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

Data will be made available on request.

References

Alcalde-Calonge, A., Sáez-Martínez, F.J., Ruiz-Palomino, P., 2022. Evolution of research on circular economy and related trends and topics. A thirteen-year review. In: Ecological Informatics, vol. 70. Elsevier B.V. https://doi.org/10.1016/j.ecoinf.2022.101716.

Anastasiades, K., Blom, J., Buyle, M., Audenaert, A., 2020. Translating the circular economy to bridge construction: lessons learnt from a critical literature review. In: Renewable and Sustainable Energy Reviews, vol. 117. Elsevier Ltd. https://doi.org/10.1016/j.rser.2019.109522.

Androniceanu, A., Kinnunen, J., Georgescu, I., 2021. Circular economy as a strategic option to promote sustainable economic growth and effective human development. Journal of International Studies 14 (1), 60–73. https://doi.org/10.14254/2071-8330.2021/14-1/4.

Bainbridge, C., 1996. The process approach — an enhanced model for managing change. Strat. Change 5 (1), 49–56. https://doi.org/10.1002/(SICI)1099-1697(199601)5:1<49::AID-JSC194>3.0.CO;2-F.

Barros, M.V., Salvador, R., do Prado, G.F., de Francisco, A.C., Piekarski, C.M., 2021. Circular economy as a driver to sustainable businesses. In: Cleaner Environmental Systems, vol. 2. Elsevier Ltd. https://doi.org/10.1016/j.cesys.2020.100006.

Bigerna, S., Micheli, S., Polinori, P., 2021. New generation acceptability towards durability and repairability of products: circular economy in the era of the 4th industrial revolution. Technol. Forecast. Soc. Change 165, 120558. https://doi.org/10.1016/j.techfore.2020.120558.

Bleischwitz, R., Yang, M., Huang, B., Xu, X., Zhou, J., McDowall, W., Andrews-Speed, P., Liu, Z., Yong, G., 2022. The circular economy in China: achievements, challenges and potential implications for decarbonisation. In: Resources, Conservation and Recycling, vol. 183. Elsevier B.V. https://doi.org/10.1016/j.resconrec.2022.106350.
Chouinard, U., Pigosso, D.C.A., McAloone, T.C., Baron, L., Achiche, S., 2019. Potential of circular economy implementation in the mechatronics industry: an exploratory research. J. Clean. Prod. 239. https://doi.org/10.1016/j.jclepro.2019.118014.
Corvellec, H., Stowell, A.F., Johansson, N., 2022. Critiques of the circular economy. J. Ind. Ecol. 26 (2), 421–432. https://doi.org/10.1111/jiec.13187.
Cui, T., Zhang, J., 2018. Bibliometric and review of the research on circular economy through the evolution of Chinese public policy. Scientometrics 116 (2), 1013–1037. https://doi.org/10.1007/s11192-018-2782-y.
Daglis, T., Tsironis, G., Tsagarakis, K.P., 2023. Data mining techniques for the investigation of the circular economy and sustainability relationship. Resources, Conservation & Recycling Advances 19, 200151. https://doi.org/10.1016/j.rcradv.2023.200151.
Dahlsrud, A., 2008. How corporate social responsibility is defined: an analysis of 37 definitions. Corp. Soc. Responsib. Environ. Manag. 15 (1), 1–13. https://doi.org/10.1002/csr.132.
Danish, M.S.S., Senjyu, T., 2023. Shaping the future of sustainable energy through AI-enabled circular economy policies. Circular Economy 2 (2). https://doi.org/10.1016/j.cec.2023.100040.
de Jesus, A., Mendonça, S., 2018. Lost in transition? Drivers and barriers in the eco-innovation road to the circular economy. Ecol. Econ. 145, 75–89. https://doi.org/10.1016/j.ecolecon.2017.08.001.
De Pascale, A., Arbolino, R., Szopik-Depczyńska, K., Limosani, M., Ioppolo, G., 2021. A systematic review for measuring circular economy: the 61 indicators. J. Clean. Prod. 281. https://doi.org/10.1016/j.jclepro.2020.124942.
Dey, P.K., Malesios, C., De, D., Budhwar, P., Chowdhury, S., Cheffi, W., 2020. Circular economy to enhance sustainability of small and medium-sized enterprises. Bus. Strat. Environ. 29 (6), 2145–2169. https://doi.org/10.1002/bse.2492.
Elia, V., Gnoni, M.G., Tornese, F., 2017. Measuring circular economy strategies through index methods: a critical analysis. J. Clean. Prod. 142, 2741–2751. https://doi.org/10.1016/j.jclepro.2016.10.196.
Elkington, J., 1998. Cannibals with Forks: the Triple Bottom Line of 21st Century Business. New Society Publishers.
Evans, S., Vladimirova, D., Holgado, M., Van Fossen, K., Yang, M., Silva, E.A., Barlow, C. Y., 2017. Business model innovation for sustainability: towards a unified perspective for creation of sustainable business models. Bus. Strat. Environ. 26 (5), 597–608. https://doi.org/10.1002/bse.1939.
Filipe, S.F., Grammatikos, T., Michala, D., 2016. Forecasting distress in European SME portfolios. J. Bank. Finance 64, 112–135. https://doi.org/10.1016/j.jbankfin.2015.12.007.
Geissdoerfer, M., Savaget, P., Bocken, N.M.P., Hultink, E.J., 2017. The Circular Economy – a new sustainability paradigm?. In: Journal of Cleaner Production, vol. 143. Elsevier Ltd, pp. 757–768. https://doi.org/10.1016/j.jclepro.2016.12.048.
Geng, Y., Fu, J., Sarkis, J., Xue, B., 2012. Towards a national circular economy indicator system in China: an evaluation and critical analysis. J. Clean. Prod. 23 (1), 216–224. https://doi.org/10.1016/j.jclepro.2011.07.005.
Ghisellini, P., Cialani, C., Ulgiati, S., 2016. A review on circular economy: the expected transition to a balanced interplay of environmental and economic systems. J. Clean. Prod. 114, 11–32. https://doi.org/10.1016/j.jclepro.2015.09.007.
Giorgi, S., Lavagna, M., Wang, K., Osmani, M., Liu, G., Campioli, A., 2022. Drivers and barriers towards circular economy in the building sector: stakeholder interviews and analysis of five european countries policies and practices. J. Clean. Prod. 336. https://doi.org/10.1016/j.jclepro.2022.130395.
Gonella, J., dos, S.L., Godinho Filho, M., Ganga, G.M.D., Latan, H., Chiappetta Jabbour, C.J., 2023. Towards a regenerative economy: an innovative scale to measure people's awareness of the circular economy. J. Clean. Prod. 421. https://doi.org/10.1016/j.jclepro.2023.138390.
Gotsch, M., Gandenberger, C., Serafimov, L., Miemiec, M., 2023. Top-down and bottom-up strategies for the implementation of corporate social responsibility: a qualitative survey of an international IT services company. Corp. Soc. Responsib. Environ. Manag. 30 (4), 1645–1663. https://doi.org/10.1002/csr.2441.
Guinée, J.B., Heijungs, R., Huppes, G., Zamagni, A., Masoni, P., Buonamici, R., Ekvall, T., Rydberg, T., 2011. Life cycle assessment: past, present, and future. Environ. Sci. Technol. 45 (1), 90–96. https://doi.org/10.1021/es101316v.
Guo, B., Geng, Y., Sterr, T., Zhu, Q., Liu, Y., 2017. Investigating public awareness on circular economy in western China: a case of Urumqi Midong. J. Clean. Prod. 142, 2177–2186. https://doi.org/10.1016/j.jclepro.2016.11.063.
Harmaala, M.-M., 2021. Transition from linear to circular business models with service design methodology to drive innovation and growth. In: Haaga-Helia Business Innovation Conference 2020, pp. 17–18, 11.2020.
Harwood, T.G., Garry, T., 2003. An overview of content analysis. Market. Rev. 3 (4), 479–498. https://doi.org/10.1362/146934703771910080.
Heyden, M.L.M., Fourné, S.P.L., Koene, B.A.S., Werkman, R., Ansari, S.S., 2017. Rethinking 'top-down' and 'bottom-up' roles of top and middle managers in organizational change: implications for employee support. J. Manag. Stud. 54 (7), 961–985. https://doi.org/10.1111/joms.12258.
Järvinen, L., Sinervo, R., 2020. How to create a national circular economy road map. Finnish Innovation Fund Sitra. https://www.sitra.fi/wp/wp-content/uploads/2020/09/how-to-create-a-national-circular-economy-road-map.pdf.
Jin, B., Xu, X., 2024a. Palladium price predictions via machine learning. Materials Circular Economy 6 (1), 32. https://doi.org/10.1007/s42824-024-00123-y.
Jin, B., Xu, X., 2024b. Price forecasting through neural networks for crude oil, heating oil, and natural gas. Measurement: Energy 1, 100001. https://doi.org/10.1016/j.meaene.2024.100001.
Johansson, N., 2021. Does the EU's action plan for a circular economy challenge the linear economy?. In: Environmental Science and Technology, vol. 55. American Chemical Society, pp. 15001–15003. https://doi.org/10.1021/acs.est.1c06194, 22.
Joung, C.B., Carrell, J., Sarkar, P., Feng, S.C., 2013. Categorization of indicators for sustainable manufacturing. Ecol. Indicat. 24, 148–157. https://doi.org/10.1016/j.ecolind.2012.05.030.
Katsanakis, N., Ibn-Mohammed, T., Moradlou, H., Godsell, J., 2023. Circular economy strategies for life cycle management of returnable transport items. Sustain. Prod. Consum. 43, 333–348. https://doi.org/10.1016/j.spc.2023.11.016.
Kirchherr, J., Piscicelli, L., Bour, R., Kostense-Smit, E., Muller, J., Huibrechtse-Truijens, A., Hekkert, M., 2018. Barriers to the circular economy: evidence from the European union (EU). Ecol. Econ. 150, 264–272. https://doi.org/10.1016/j.ecolecon.2018.04.028.
Kirchherr, J., Reike, D., Hekkert, M., 2017. Conceptualizing the circular economy: an analysis of 114 definitions. In: Resources, Conservation and Recycling, vol. 127. Elsevier B.V, pp. 221–232. https://doi.org/10.1016/j.resconrec.2017.09.005.
Kirchherr, J., Yang, N.H.N., Schulze-Spüntrup, F., Heerink, M.J., Hartley, K., 2023. Conceptualizing the circular economy (revisited): an analysis of 221 definitions. In: Resources, Conservation and Recycling, vol. 194. Elsevier B.V. https://doi.org/10.1016/j.resconrec.2023.107001.
Koistinen, K., Onkila, T., Teerikangas, S., Mäkelä, M., Sarja, M., Valkjärvi, M., 2022. Bold ambition, blunted agency? Examining top management perspectives on a circular economy transition in Finland. Energy Res. Social Sci. 86. https://doi.org/10.1016/j.erss.2021.102451.
Kristensen, H.S., Mosgaard, M.A., 2020. A review of micro level indicators for a circular economy – moving away from the three dimensions of sustainability?. In: Journal of Cleaner Production, vol. 243. Elsevier Ltd. https://doi.org/10.1016/j.jclepro.2019.118531.
Lahane, S., Prajapati, H., Kant, R., 2021. Emergence of circular economy research: a systematic literature review. In: Management of Environmental Quality: an International Journal, vol. 32. Emerald Group Holdings Ltd, pp. 575–595. https://doi.org/10.1108/MEQ-05-2020-0087, 3.
Lieder, M., Rashid, A., 2016. Towards circular economy implementation: a comprehensive review in context of manufacturing industry. In: Journal of Cleaner Production, vol. 115. Elsevier Ltd, pp. 36–51. https://doi.org/10.1016/j.jclepro.2015.12.042.
Linder, M., Sarasini, S., van Loon, P., 2017. A metric for quantifying product-level circularity. J. Ind. Ecol. 21 (3), 545–558. https://doi.org/10.1111/jiec.12552.
Liu, Q., Li, H., Zuo, X., Zhang, F., Wang, L., 2009. A survey and analysis on public awareness and performance for promoting circular economy in China: a case study from Tianjin. J. Clean. Prod. 17 (2), 265–270. https://doi.org/10.1016/j.jclepro.2008.06.003.
Liu, Y., Bai, Y., 2014. An exploration of firms' awareness and behavior of developing circular economy: an empirical research in China. Resour. Conserv. Recycl. 87, 145–152. https://doi.org/10.1016/j.resconrec.2014.04.002.
Manoharan, S., Kumar Pulimi, V.S., Kabir, G., Ali, S.M., 2022. Contextual relationships among drivers and barriers to circular economy: an integrated ISM and DEMATEL approach. Sustainable Operations and Computers 3, 43–53. https://doi.org/10.1016/j.susoc.2021.09.003.
Meili, R., Stucki, T., 2023. Money matters: the role of money as a regional and corporate financial resource for circular economy transition at firm-level. Res. Pol. 52 (10), 104884. https://doi.org/10.1016/j.respol.2023.104884.
Merli, R., Preziosi, M., Acampora, A., 2018. How do scholars approach the circular economy? A systematic literature review. In: Journal of Cleaner Production, vol. 178. Elsevier Ltd, pp. 703–722. https://doi.org/10.1016/j.jclepro.2017.12.112.
Millar, N., McLaughlin, E., Börger, T., 2019. The circular economy: swings and roundabouts?. In: Ecological Economics, vol. 158. Elsevier B.V, pp. 11–19. https://doi.org/10.1016/j.ecolecon.2018.12.012.
Mom, T.J.M., Van Den Bosch, F.A.J., Volberda, H.W., 2007. Investigating managers' exploration and exploitation activities: the influence of top-down, bottom-up, and horizontal knowledge inflows. J. Manag. Stud. 44 (6), 910–931. https://doi.org/10.1111/j.1467-6486.2007.00697.x.
Moraga, G., Huysveld, S., Mathieux, F., Blengini, G.A., Alaerts, L., Van Acker, K., de Meester, S., Dewulf, J., 2019. Circular economy indicators: what do they measure? Resour. Conserv. Recycl. 146, 452–461. https://doi.org/10.1016/j.resconrec.2019.03.045.
Morseletto, P., 2020. Targets for a circular economy. Resour. Conserv. Recycl. 153. https://doi.org/10.1016/j.resconrec.2019.104553.
Mukherjee, P.K., Das, B., Bhardwaj, P.K., Tampha, S., Singh, H.K., Chanu, L.D., Sharma, N., Devi, S.I., 2023. Socio-economic sustainability with circular economy — an alternative approach. In: Science of the Total Environment, vol. 904. Elsevier B.V. https://doi.org/10.1016/j.scitotenv.2023.166630.
Munaro, M.R., Tavares, S.F., 2023. A review on barriers, drivers, and stakeholders towards the circular economy: the construction sector perspective. Cleaner and Responsible Consumption 8. https://doi.org/10.1016/j.clrc.2023.100107.
Murray, A., Skene, K., Haynes, K., 2017. The circular economy: an interdisciplinary exploration of the concept and application in a global context. J. Bus. Ethics 140 (3), 369–380. https://doi.org/10.1007/s10551-015-2693-2.
Narver, J.C., Slater, S.F., Tietje, B., 1998. Creating a market orientation. J. Mark.-Focused Manag. 2 (3), 241–255. https://doi.org/10.1023/A:1009703717144.
Nwodo, M.N., Anumba, C.J., 2019. A review of life cycle assessment of buildings using a systematic approach. Build. Environ. 162, 106290. https://doi.org/10.1016/j.buildenv.2019.106290.

Ormazabal, M., Prieto-Sandoval, V., Puga-Leal, R., Jaca, C., 2018. Circular economy in Spanish SMEs: challenges and opportunities. J. Clean. Prod. 185, 157–167. https://doi.org/10.1016/j.jclepro.2018.03.031.

Papageorgiou, A., Henrysson, M., Nuur, C., Sinha, R., Sundberg, C., Vanhuyse, F., 2021. Mapping and assessing indicator-based frameworks for monitoring circular economy development at the city-level. Sustain. Cities Soc. 75. https://doi.org/10.1016/j.scs.2021.103378.

Pauliuk, S., 2018. Critical appraisal of the circular economy standard BS 8001:2017 and a dashboard of quantitative system indicators for its implementation in organizations. Resour. Conserv. Recycl. 129, 81–92. https://doi.org/10.1016/j.resconrec.2017.10.019.

Pitkänen, K., Karppinen, T.K.M., Kautto, P., Pirtonen, H., Salmenperä, H., Savolahti, H., Schubin, E., Myllymaa, T., 2023. How to measure the social sustainability of the circular economy? Developing and piloting social circular economy indicators in Finland. J. Clean. Prod. 392, 136238. https://doi.org/10.1016/j.jclepro.2023.136238.

Potting, J., Hanemaaijer, A., Delahaye, R., Ganzevles, J., Hoekstra, R., Lijzen, J., 2018. Circular Economy: what we want to know and can measure - system and baseline assessment for monitoring the progress of the circular economy in The Netherlands. https://www.pbl.nl/en/publications/circular-economy-what-we-want-to-know-and-can-measure.

Potting, J., Hekkert, M., Worrell, E., Hanemaaijer, A., 2017. Circular economy: measuring innovation in the product chain policy report. https://www.pbl.nl/en/publications/circular-economy-measuring-innovation-in-product-chains.

Provin, A.P., Dutra, A.R. de A., de Sousa e Silva Gouveia, I.C.A., Cubas, e.A.L. V., 2021. Circular economy for fashion industry: use of waste from the food industry for the production of biotextiles. Technol. Forecast. Soc. Change 169. https://doi.org/10.1016/j.techfore.2021.120858.

Ranta, V., Aarikka-Stenroos, L., Ritala, P., Mäkinen, S.J., 2018. Exploring institutional drivers and barriers of the circular economy: a cross-regional comparison of China, the US, and Europe. Resour. Conserv. Recycl. 135, 70–82. https://doi.org/10.1016/j.resconrec.2017.08.017.

Rashid, M.I., Shahzad, K., 2021. Food waste recycling for compost production and its economic and environmental assessment as circular economy indicators of solid waste management. J. Clean. Prod. 317. https://doi.org/10.1016/j.jclepro.2021.128467.

Reike, D., Vermeulen, W.J.V., Witjes, S., 2018. The circular economy: new or refurbished as CE 3.0? — Exploring controversies in the conceptualization of the circular economy through a focus on history and resource value retention options. Resour. Conserv. Recycl. 135, 246–264. https://doi.org/10.1016/j.resconrec.2017.08.027.

Rizos, V., Bryhn, J., Alessi, M., Righetti, E., Fujiwara, N., Stroia, C., 2021. Barriers and enablers for implementing circular economy business models: evidence from the electrical and electronic equipment and agri-food value chains. https://www.ceps.eu/ceps-publications/barriers-and-enablers-for-implementing-circular-economy-business-models/.

Rótolo, G.C., Vassillo, C., Rodriguez, A.A., Magnano, L., Milo Vaccaro, M., Civit, B.M., Covacevich, M.S., Arena, A.P., Ulgiati, S., 2022. Perception and awareness of circular economy options within sectors related to agriculture in Argentina. J. Clean. Prod. 373. https://doi.org/10.1016/j.jclepro.2022.133805.

Saidani, M., Yannou, B., Leroy, Y., Cluzel, F., 2017. Hybrid top-down and bottom-up framework to measure products' circularity performance, 17. https://hal.science/hal-01571581.

Saidani, M., Yannou, B., Leroy, Y., Cluzel, F., Kendall, A., 2019. A taxonomy of circular economy indicators. In: Journal of Cleaner Production, vol. 207. Elsevier Ltd, pp. 542–559. https://doi.org/10.1016/j.jclepro.2018.10.014.

Santolin, R.B., Hameed, H. Bin, Urbinati, A., Lazzarotti, V., 2023. Exploiting circular economy enablers for SMEs to advance towards a more sustainable development: an empirical study in the post COVID-19 era. Resources, Conservation and Recycling Advances 19. https://doi.org/10.1016/j.rcradv.2023.200164.

Schöggl, J.P., Stumpf, L., Baumgartner, R.J., 2020. The narrative of sustainability and circular economy - a longitudinal review of two decades of research. In: Resources, Conservation and Recycling, vol. 163. Elsevier B.V. https://doi.org/10.1016/j.resconrec.2020.105073.

Suárez-Eiroa, B., Fernández, E., Méndez-Martínez, G., Soto-Oñate, D., 2019. Operational principles of circular economy for sustainable development: linking theory and practice. In: Journal of Cleaner Production, vol. 214. Elsevier Ltd, pp. 952–961. https://doi.org/10.1016/j.jclepro.2018.12.271.

Tapaninaho, R., Heikkinen, A., 2022. Value creation in circular economy business for sustainability: a stakeholder relationship perspective. Bus. Strat. Environ. 31 (6), 2728–2740. https://doi.org/10.1002/bse.3002.

Truant, E., Giordino, D., Borlatto, E., Bhatia, M., 2024. Drivers and barriers of smart technologies for circular economy: leveraging smart circular economy implementation to nurture companies' performance. Technol. Forecast. Soc. Change 198, 122954. https://doi.org/10.1016/j.techfore.2023.122954.

Tura, N., Hanski, J., Ahola, T., Ståhle, M., Piiparinen, S., Valkokari, P., 2019. Unlocking circular business: a framework of barriers and drivers. J. Clean. Prod. 212, 90–98. https://doi.org/10.1016/j.jclepro.2018.11.202.

Vinante, C., Sacco, P., Orzes, G., Borgianni, Y., 2021. Circular economy metrics: literature review and company-level classification framework. In: Journal of Cleaner Production, vol. 288. Elsevier Ltd. https://doi.org/10.1016/j.jclepro.2020.125090.

Willaert, P., Van den Bergh, J., Willems, J., Deschoolmeester, D., 2007. The Process-Oriented Organisation: A Holistic View Developing a Framework for Business Process Orientation Maturity, pp. 1–15. https://doi.org/10.1007/978-3-540-75183-0_1.

Xue, B., Chen, X.P., Geng, Y., Guo, X.J., Lu, C.P., Zhang, Z.L., Lu, C.Y., 2010. Survey of officials' awareness on circular economy development in China: based on municipal and county level. Resour. Conserv. Recycl. 54 (12), 1296–1302. https://doi.org/10.1016/j.resconrec.2010.05.010.