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Business management perspectives on the circular economy: Present state and future directions

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Abstract

Circular economy (CE) is an economic model designed to substitute the take-make-dispose linear economy with a regenerative system. Business management has a critical role in translating CE into practice. Extant management research on CE, while expanding rapidly, remains fragmented and lacks a holistic perspective. Through bibliographic coupling, a technique that identifies emergent research trends rather than past traditions in literature, we analyse the current state of CE research in business management and develop an agenda for future research. Six streams emerge: *strategy, learning and innovation*, *consumer behaviour and remanufacturing*, *supply chains and implementation*, *circular business models*, *industrial symbiosis*, and *emerging technologies*. Through content analysis we explore research trends and gaps, providing a more comprehensive overview of CE management research than prior studies. Moreover, we identify promising paths for future research, focused around three overarching research questions that provide a platform to accelerate the impact of business and management research on the adoption and proliferation of CE practices in future.

1. Introduction

The Circular Economy (CE) is a relatively new, multidisciplinary field of research (Jabbour et al., 2019). Natural resource depletion and environmental degradation have underlined the necessity of redesigning the traditional linear "take-make-dispose" path of production and consumption (Merli et al., 2018). CE is "*an economic system that replaces the 'end-of-life' concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes*" (Kirchherr et al., 2017, p. 229). Outputs previously conceptualised as waste are now seen as a resource to create value. Value is retained in the economic system by redesigning products (Guldmann and Huulgaard, 2020) and by extending product life (Kristoffersen et al., 2021b; Merli et al., 2018). Despite vast potential, only 8.6 % of the economy is estimated to be circular (Circularity Gap Report, 2022). To transform the economy to one where waste is no longer produced, materials are reused and nature is regenerated, a systemic shift is needed to put circularity at the heart of all business activity. While CE originally evolved from a more technical perspective, researchers have increasingly acknowledged the need for fundamental transitions of business strategies, supply chains, business models and ultimately across society (Ferasso et al., 2020; Ghisellini et al., 2016; Kirchherr et al., 2017).

Transition to CE therefore requires not only changes in products and processes but also fundamental shifts in underlying value creation and consumption patterns (De Angelis, 2021). Such a systemic shift requires seeing businesses as a part of a wider system consisting of multiple interdependent members (Perey et al., 2018). Given this rising importance of the topic in recent years, CE is becoming a fast-growing topic in management research. Extensive research in recent years has resulted in an expansive body of CE business and management knowledge. To the best of our knowledge, the scope of this emerging area of management research has not been rigorously reviewed and consolidated. A need therefore arises to analyse the current state of management research to understand its intellectual structure, create a comprehensive body of organised knowledge, identify future research potential and ultimately facilitate a more substantive contribution to CE in future.

Various reviews of CE have been conducted; in their review on the evolution of the CE concept, Alcalde-Calonge et al. (2022) found CE literature split into two broad areas: 1) management scholars conceptualising CE in relation to current theories, business processes and strategies, analysing its implications in the creation of new business models and implementation in particular industries and 2) engineers

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and environmental scientists investigating applications of CE and searching for solutions to manufacturing and environmental problems. This study aims to map the emergent research topics in the former area.

Previous literature reviews of CE have had multiple foci, for example, on manufacturing industry (Lieder and Rashid, 2016), innovation and CE (Suchek et al., 2021), comparison of CE and sustainable business (Murray et al., 2017), circular business models (Ferasso et al., 2020; Hofmann, 2019) and digitalisation (Chauhan et al., 2022). Most of these reviews have focused on specific aspects of CE and lack comprehensive coverage of CE research from a management perspective. Moreover, many of the previous reviews provide descriptive analyses of scientific outputs, such as annual trends, keyword co-occurrence, and co-authorship (Lozano et al., 2021). Given that fragmented research streams and a lack of systemic perspective conflict with the principles of CE (Chen et al., 2020), there is a need to strengthen the impact of management research in this area. We therefore add to previous research by reviewing the current state of business management research in CE and developing suggested future directions designed to increase both integration and impact.

Our research questions are:

- What is the current state of recent/emerging perspectives related to CE in business and management literature?
- How can business and management research better support the transition to a Circular Economy?

This study is distinct in several ways. First, we cover business and management as a discipline holistically and do not limit the study to business- or CE-specific topics, the approach of most prior bibliometric reviews. Second, we adopt a hybrid approach using content analysis applied to bibliometric and network analysis results, increasing the efficiency of individual methods and providing a panoramic as well as in-depth insights beyond simple descriptives. Third, in contrast to prior studies, we employ an emerging bibliometric technique known as bibliometric coupling, which captures emerging trends rather than past traditions in the scientific literature (Mariani and Borghi, 2019). This approach yields critical insights in such a rapidly evolving area with a dramatic increase in published articles over the past few years (Goyal et al., 2021).

Our paper is structured as follows. First, we discuss in detail the method we applied, including our inclusion and exclusion criteria and the process followed to arrive at our final sample of literature. We follow this with an in-depth exploration of each of the six research streams that emerged. Next we examine research trends and gaps in each stream, finding a number of opportunities for research both within and across streams. We use this analysis to develop three overarching questions to guide future research. The overall outcomes of our study are a deeper understanding of the intellectual structure of recent managerial-focused CE literature and a research agenda to accelerate the impact of business and management research on the transition to CE.

2. Research design

A bibliometric approach was employed to analyse the state of the art in CE and its major streams of research in business and management. Bibliometric analysis is a 'set of quantitative methods used for analysing academic literature' (Belussi et al., 2019, p.2), and is used to identify the intellectual structure of a field and its development. Bibliometrics employ a quantitative approach for selection and evaluation of published literature. Therefore, compared to qualitative literature reviews, which can suffer from subjectivity, bibliometric reviews can be seen as more systematic, transparent and reproducible (Zupic and Čater, 2015).

Given our aim was to map emerging CE research in business and management, bibliographic coupling was selected as the method for data analysis. Bibliographic coupling, introduced by Kessler (1963), is a useful method for identifying current research streams and frontiers, particularly for rapidly evolving fields (Mariani and Borghi, 2019). Building on the assumption that documents citing common references are likely to cover similar research topics, bibliographic coupling infers similarity between two documents based on the overlap in their list of references (Agostini and Nosella, 2019). Because the coupling relationship is established using the most recent citing documents, the method has been found to outperform more traditional methods such as co-citation analysis in the identification of emerging research trends (Boyack and Klavans, 2010).

2.1. Data collection

2.1.1. Identifying keywords for search

Data were collected from Clarivate Web of Science (WOS), a common source of bibliometric data (Zupic and Čater, 2015). Relevant search terms were identified through an initial literature review. Initially '*circular* *econom*' was searched in WOS, and the resulting top 50 most cited papers were examined to identify terms used synonymously to CE in extant literature. In the end our final set of search terms included four keywords: circular economy, cradle to cradle, industrial symbiosis and closed-loop economy.

2.1.2. Selecting the relevant papers

To curate relevant literature the four key terms were 'topic-searched' (i.e., title, abstract or keywords) in WOS. The search was refined to include articles published in peer reviewed journals in the categories of business, finance, management, operations research management science, and economics. These categories align with our objective to review literature on CE in management and related areas. We also included papers published in the Journal of Cleaner Production, given its prominence in CE research combined with its treatment as a business journal in the Chartered Association of Business School (CABS) Journal Guide. Although the limitations of such lists are widely acknowledged, (e.g. Robinson et al., 2021) the CABS list is widely used in business schools to assess journal quality and scope of acceptable publication outlets. Article language was limited to English and no temporal limitation was applied.

The four search terms and selection criteria resulted in 2108 articles. These articles were manually reviewed to filter out irrelevant articles — those which tentatively mention circular economy or are technical in nature. At the end of this step, 1232 articles were retained for bibliographic coupling analysis. Of note at this stage was the significant growth that occurred in the last four years, overall accounting for 88 % of all publications on CE (see Fig. 1).

2.2. Bibliographic coupling and data analysis

To identify emerging research streams, bibliographic coupling analysis starts with the construction of a similarity matrix containing all retrieved documents on the first row and column with strength of relationship between them displayed in corresponding cells. We used BibExcell – a commonly used data processing tool for bibliometric analysis (Persson et al., 2009) to construct a similarity matrix.

Next, the similarity matrix was processed using network analysis. Network analysis is preferable to more traditional multidimensional scaling approaches as it is more effective in finding streams of research in a field (Zupic and Čater, 2015) and is increasingly common in bibliometric studies (e.g. Agostini and Nosella, 2019; Mariani and Borghi, 2019; Mura et al., 2018). We used Gephi network analysis software and applied the Louvain community detection algorithm to produce network partitions or emerging streams of research. Louvain community detection was introduced by Blondel et al. (2008) and has been found to be fast and accurate in detecting communities even in large networks (Mura et al., 2018; Zupic and Čater, 2015). This algorithm uses the notion of modularity, where density of links within communities is compared against links between communities to enhance meaning and

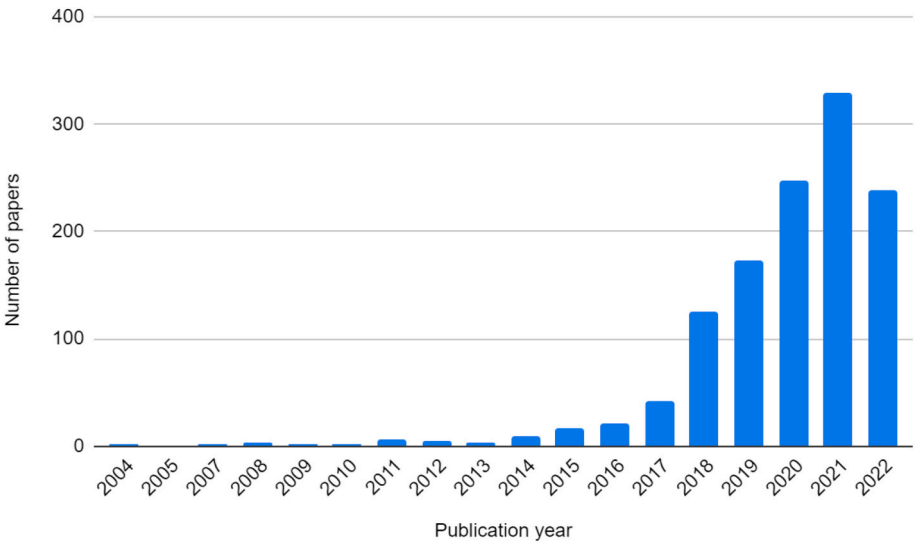

Fig. 1. CE publications overview.

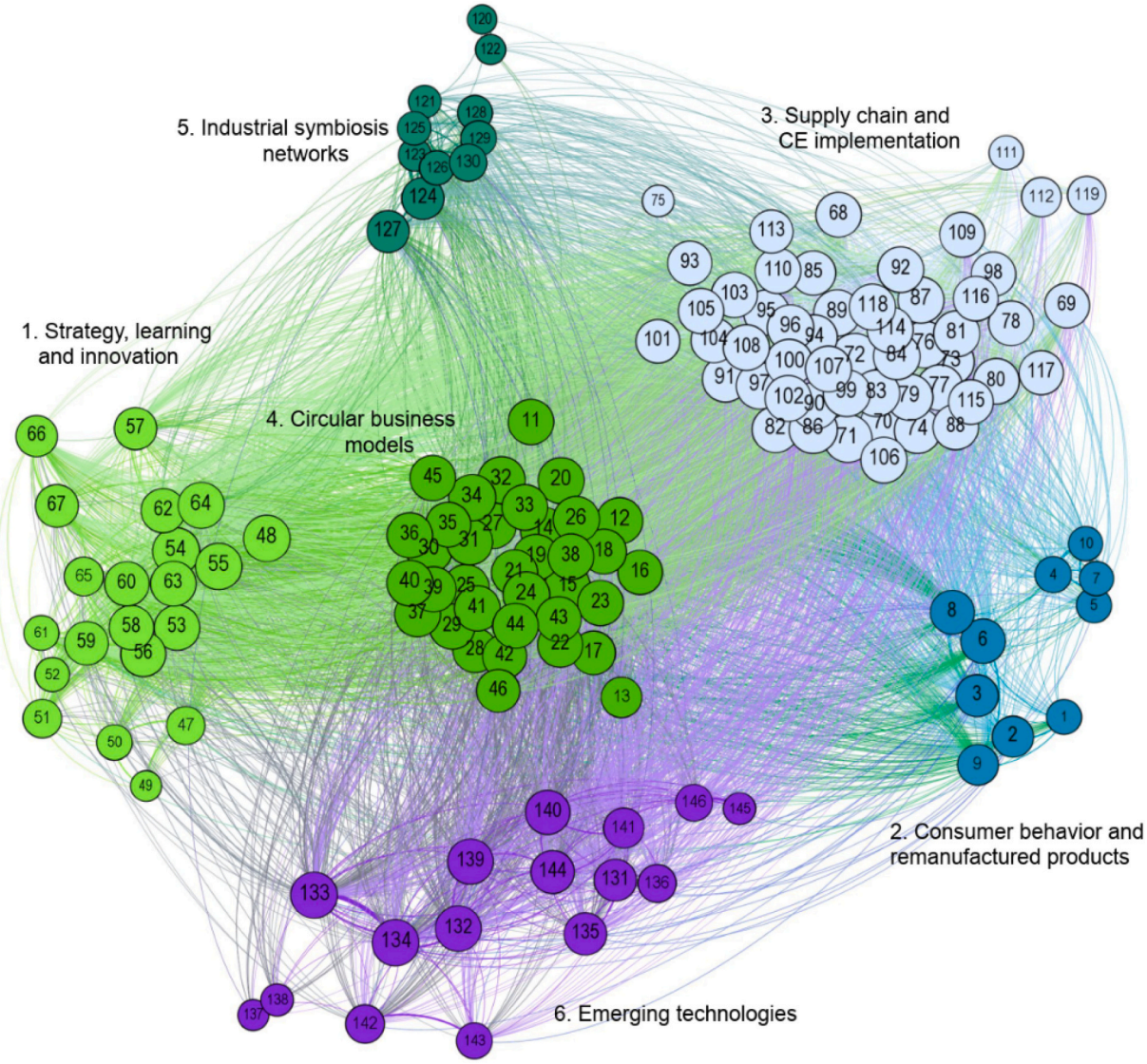

Fig. 2. The identified streams with included articles.

differentiation of communities in a network (Blondel et al., 2008).

The Louvain algorithm assigns a community to each node; therefore it is important to filter closely relevant papers in the field beforehand (Zupic and Čater, 2015). To this end we used the threshold approach that allows selection of strongly tied documents and hence focuses on core literature. As is common practice in bibliometric studies (e.g. Mariani and Borghi, 2019; Mura et al., 2018), we tried different thresholds to test whether changes in thresholds lead to major variations in the network structure. Overall, we did not find significant changes in the identified communities. Ultimately a threshold of 20 with one was selected, meaning only documents with at least 20 shared references with at least one other document were retained. This resulted in a set of 146 documents (see table A1), producing a tightly focused yet complete set of results.

Our final result comprised six communities, which we refer to as streams. Overall, the final structure of the network comprised 146 nodes, 7348 edges, with a modularity of 0.15. Fig. 2 provides a visual presentation of the six streams, which include 21 articles in stream 1, 10 articles in stream 2, 52 articles in stream 3, 36 articles in stream 4, 11 articles in stream 5 and 16 articles in stream 6. In the figure size of each node varies according to its degree that is the number of links.

Finally, each stream was content analysed. An overview of the analytical process is provided in the Fig. 3.

3. Findings

The top five journals, in our final sample of 146 articles, are Journal of Cleaner Production, Business Strategy and the Environment, International Journal of Production Research, Ecological Economics and Technological Forecasting and Social Change. These five journals together are the source of almost 70 % of the sampled documents. Please see Appendix 1 for a summary list of analysed articles.

Next, we turn to a more detailed content analysis of the six streams and development of a research agenda. Each stream was analysed in terms of scopes (Lozano et al., 2021), major topics forming subcategories, as well as for its wider implications for CE research. Lozano et al.'s (2021, p. 7) eight scopes cover country/national/international, cluster, sector, process, organisation, individual, assessment and review. Consequently, several subthemes were identified. More generally, we also noted a significant emphasis across streams on drivers, barriers and enablers of CE and limited yet diverse use of theory. In this section we present the six research streams, exploring their internal composition and major topics.

3.1. Stream 1: strategy, learning and innovation

This stream comprises studies using ideas from the field of strategic management and organisation theory to explore CE and is broken down into three subthemes. The majority of papers in this stream focus on organisations, with a small number having sector and national/regional scopes. Some studies in the third subtheme use an assessment approach. The first subtheme uses dynamic capabilities and the resource based view of the firm to explore CE issues. Resources, competences and dynamic capabilities (Kiefer et al., 2019) link positively to developing CE activities and various enablers, such as physical resource capabilities and an environmentally friendly corporate culture, and barriers, such as technological path dependency, have been identified. A clear link between dynamic capabilities and the development of CE practices has been established (Khan et al., 2020b). Further, a set of sensing, seizing and transforming capabilities and routines relating to CE practices development have been developed and empirically tested (Khan et al., 2020a, 2021a). Recent findings in this area suggest that dynamic capabilities contribute to firms' ability to adapt to new environmental management standards and performance criteria (Marrucci et al., 2022b). These studies overall identify important barriers, firm enablers and environmental conditions that support CE.

The second subtheme relates to design and innovation, covering the domain of eco-design and eco-innovation. Again, thinking was underpinned by strategic management theory linked to the capability view of strategy. Eco-innovation is defined the "*production, assimilation, or exploitation of a product, production process, service, or management or business method that is novel to the organisation (developing or adopting it)*

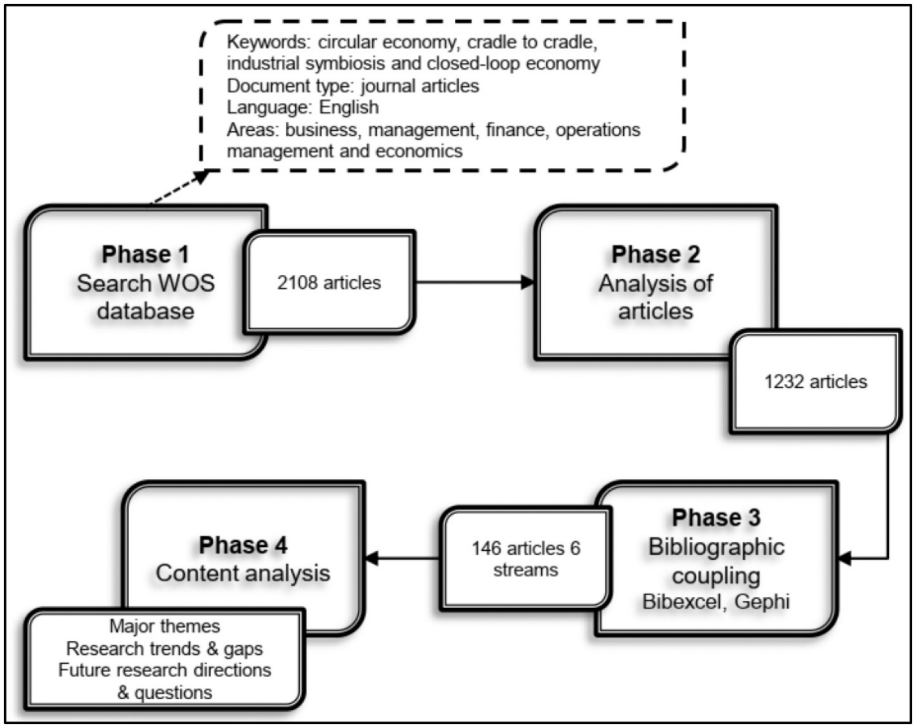

Fig. 3. Research design.

and that results, throughout its life cycle, in a reduction in environmental risk, pollution, and other negative impacts of resource use (including energy use) compared to relevant alternatives" (Kemp and Pearson, 2007). Overall findings suggest variable approaches and attitudes to eco-design, depending on domain. One study (Sihvonen and Partanen, 2017) suggests that environmental considerations have not yet become a mainstream topic within product development practices and there remains significant potential for more frequent inclusion of environmental considerations within various product development phases. Another study by the same authors (Sihvonen and Partanen, 2016) found high levels of awareness among employees and the significant role of individual eco-concern in motivating more environmentally aware practices. Other studies (Scarpellini et al., 2018; Scarpellini et al., 2020a, b) identified the link between eco-innovation in certain areas and the development of CE practices more widely and the way in which financial resources can shape CE practices.

The third subtheme relates to organisational learning. A number of studies have examined the role of organisational learning in CE adoption. It has been suggested, for example, that absorptive capacity, a firm's ability to assimilate new knowledge and exploit it for commercial gain, is critical in providing a platform for CE adaptation (Marrucci et al., 2022a). Other recent studies in this area have examined the role of green HRM practices in fostering organisational learning (Subramanian and Suresh, 2022). Several studies have also explored performance measurement and the types of indicators that can be used to measure transition to CE. For example, Rossi et al. (2020) combined CE indicators with the three pillars of sustainability to illustrate how indicators link to circular business models (CBMs - discussed in detail in stream 4). Rincon-Moreno et al. (2021) suggest a number of indicators and test their applicability, which allows data-driven decision-making to support organisational change.

3.2. Stream 2: consumer behaviour and remanufactured products

This stream addresses social and technical remanufacturing-related issues. CE activities covered in this stream included individual, for example articles focusing on consumer willingness to purchase remanufactured products, assessment, examining bullwhip effect and inventory policies) and organisation, documenting firms' transition to CE.

The first subtheme examines consumer acceptance of remanufactured products, a critical yet underexplored topic. Consumers' willingness to appreciate and purchase remanufactured products is critical to CE, improving the potential to building successful closed-loop supply chains. Regarding circular knowledge, awareness of remanufacturing processes, product history, and remarketing efforts by the company can instil confidence and build positive attitudes among potential customers of remanufactured products (Wang et al., 2020). Similar influential drivers were also noted in the case of refurbished products by Mugge et al. (2017).

The second subtheme examines refurbished products, which are restored rather than remanufactured. Because refurbished products are not built from scratch, a negative trade-off between perceived risks (breakdown and obsolescence) and benefits (low price and environmental support) drives consumers away (van Weelden et al., 2016). Agostini et al. (2021) found that seller reputation was important for refurbished products as consumers perceive that the risk for low quality in a refurbished product is smaller if the seller is well-known, and are therefore more willing to purchase the product. However, there are studies documenting the challenges of finding a profitable remanufacturing business model. For example, leasing and remanufacturing products lead to additional costs for removal, transportation and remanufacturing, which are easily ignored in profit calculations (Dominguez et al., 2021). Companies must estimate costs and risks and acquire or outsource competences of managing these additional activities (van Loon and Van Wassenhove, 2020).

From a more operational perspective, Ponte et al. (2020) and de Arquer et al. (2022) highlight that while remanufacturing enables retaining the value of products, it complicates inventory management with uncertain quality and quantity of demand and supply and calls for information sharing across the whole supply chain. Dominguez et al. (2020) point out that the uncertain quality of returns makes lead times highly variable. Together these issues may lead to increased bullwhip effect (Ponte et al., 2020). Optimisation of inventory policies may improve resilience of the circular supply chains to disruptions (de Arquer et al., 2022).

3.3. Stream 3: supply chain and CE implementation

This stream focuses on supply chain aspects of CE and involves a number of different scopes. The most prominent of these are the organisation, followed by review articles, sector articles examining specific industries, and assessment articles. Two subthemes emerged from the content analysis.

The first examines circular supply chain management, the coordination of forward and reverse supply chains for value creation from products, by-products and waste flows (Batista et al., 2018; Agarwal et al., 2021). Batista et al. (2018) conceptualise circular supply chains in relation to other narratives, such as green supply chain management, closed-loop supply chains and sustainable supply chain management and argue that a circular supply chain integrates and builds upon other supply chain narratives. Authors within this sub-theme highlight that for the transition to CE to succeed, all partners of the supply chain must be involved (e.g. Berardi and de Brito, 2021). In addition to frequently studied supply chain members (suppliers, customers), the role of other stakeholders, such as business associations, NGOs, research institutions and transition brokers has also been examined (Cramer, 2020a, b; Ghinoi et al., 2020). Others focus on how specific supply chain practices, such as product design (Burke et al., 2021), supplier selection (Bai et al., 2022) or supply chain risk management (Dulia et al., 2021), may advance CE. Barriers to circular supply chains such as financial constraints, inadequate infrastructure, lack of government support, market barriers and social and cultural barriers, such as consumer unwillingness, have also been investigated (Agarwal et al., 2021; Ayati et al., 2022; Wang et al., 2022).

The second subtheme identifies firm-level drivers and barriers to CE. Categories of CE drivers, barriers, enablers and practices have been suggested and tested empirically, using surveys and interviews. Authors argue that CE is still in the preliminary stages of implementation, especially in emerging economies, providing a specific socioeconomic context requiring further investigation (e.g., Agyemang et al., 2019; Moktadir et al., 2020a, b). Contexts vary from automotive (Kayikci et al., 2021), construction (Charef et al., 2021), textile (Saha et al., 2021) industries and SMEs (Mathivathanan et al., 2022). The majority of these studies are not grounded in any specific theory. There are some exceptions, such as Centobelli et al. (2021) using theory of planned behaviour and Wang et al. (2022) using stakeholder theory. Chizaryfard et al. (2021) draw on the development block framework to view CE as a complex evolutionary system. They maintain that CE should be viewed as the nexus of ecological dynamics and evolutionary economic and industrial processes. Frequently appearing drivers are also identified (e.g., Farooque et al., 2019; Moktadir et al., 2020a, b). Others discuss enablers or critical success factors (e.g., Moktadir et al., 2020a, b; Singh et al., 2022).

3.4. Stream 4: circular business models

This stream comprises research on Circular Business Models (CBMs). CBMs can be defined as a subcategory of sustainable business models with a primary focus on environmental and economic outcomes creating value by slowing, intensifying and closing material loops (see e.g. Bocken et al., 2014; Ferasso et al., 2020; Geissdoerfer et al., 2020; Pollard et al., 2021; Puglieri et al., 2022). Slowing and closing loops

encourages long product life, circular product designs, recycling, reuse, refurbishing, and remanufacturing, circular services, such as sharing and leasing, and development of take-back systems. This stream can be broken down into three subthemes. In terms of scope, most papers fall into the organisation category, followed by review, process and cluster.

The first subtheme deals with CBM development and value creation. Puglieri et al. (2022) took a management approach to CBMs, providing a five-stage process framework for CBM development. Shao et al. (2020) found that customer segments, customer relationships and key partnerships are the business model components most influenced by CE strategies (Salvador et al., 2021). A study by Urbinati et al. (2017) proposed a useful taxonomy of CBMs based on their degree of circularity. Further, Brown et al. (2021a) developed and tested a tool helping companies to identify partners and measure value created. Some studies suggest that organisations must develop CE-specific organisational capabilities to better align circular product development with business model innovation (de Arroyabe et al., 2021; Hofmann and Zu Knyphausen-Aufsess, 2022).

The second subtheme examines CBM innovations. Henry et al. (2020) proposed business model-driven innovations in newly established firms and developed a typology of circular start-up archetypes. Studies have also explored how firms venture towards CBMs (Hofmann and Jaeger-Erben, 2020). Pollard et al. (2021) focused on innovation processes and developed circularity indicators to address the impact of CBM archetypes. Pieroni et al. (2021b) found potential for manufacturing firms' sectorial patterns to support CBM innovations: visualisation of viability and feasibility of CBM, strengthening motivation and arguments for implementation; and reduction of uncertainties and complexity facilitating the exploration of BMs with higher impact on CE. Franco (2017) contributed to understanding of the intersection between collaborative supplier-buyer innovation factors and complex aspects in product designs, while Brown et al. (2021a, b) contributed a strategic management view of collaborative processes.

The third subtheme addressed enablers, barriers, and drivers of CBM adoption. A suitable political and institutional environment for business development and collaboration with stakeholders are important for the creation of a new culture of sustainability (Del Vecchio et al., 2022). Nevertheless, formulation of an initial 'circular proposition' and developing circular-oriented governance and decision making, are challenging tasks for many organisations (Brown et al., 2021a, b). In addition to organisational factors, institutional pressures and coercion can also motivate company's management to CE adoption (Arranz et al., 2022). When compared to large organisations, Henry et al. (2022) found that non-economic factors such as self-realisation, social altruism and environmental altruism act as major drivers for the adoption of circular business models in SMEs.

3.5. Stream 5: industrial symbiosis networks

This stream is concerned with industrial symbiosis networks (ISNs), where multiple firms engage in exchanging waste as a resource generating economic, societal and environmental benefits. Due to the dominance of the network approach in this stream the majority of studies could be classified as cluster-focused in terms of Lozano et al.'s (2021) scopes. In general, the aim of studies in this stream was model development using simulations. Only three studies included empirical data, thus the majority relied on secondary sources such as archives and policy programmes.

Resilience of an ISN is key to accruing circularity benefits in the long run. For example, Fraccascia et al. (2017) found diversity at system- and firm-level and the ubiquity of waste as major antecedents of network resilience. They further proposed a resilience index for the assessment and enhancement of network resilience and survival. From a strategic viewpoint firms can exchange the same waste with more symbiotic partners, reducing network redundancy (Fraccascia et al., 2020) and focus on building conflict-resilient relationships. Various disruptive events leading to cooperation breakdown among firms in ISN and their effect on physical and monetary flows have also been identified (Fraccascia, 2019).

The issues of co-opetition and performance measurement have also been explored. Industrial symbiosis relationships are prone to co-opetition issues. On the one hand a firm in a network tries to reduce waste disposal and resource procurement cost, but on the other hand tries to minimise contribution to ISN operating cost (Yazan et al., 2020). For networks to reach their full potential, an equitable contribution rather than opportunistic strategy provides long-term benefits to all firms (Yazan et al., 2020). To complement this, various sets of ISN performance indicators have been developed (Fraccascia et al., 2021; Lutje and Wohlgemuth, 2020a, b). At an ecosystem level, Fraccascia et al. (2021) present an ISN performance framework encompassing five categories of indicators; impact of services to the environment, performance of services, how single functions impact services, performance of functions, and how firms impact ISN functions.

3.6. Stream 6: emerging technologies

This final stream explores the potential contribution of modern digital technologies to CE in organisations. In terms of scope most papers focus on organisation, sector and region. This stream is the newest of our six, with all papers dating from 2020 or later.

Several ways in which technology can contribute to circularity through resource optimisation and innovation have been identified (Kristoffersen et al., 2020; Liu et al., 2022). Technologies such as big data analytics, blockchain, and the 'internet of things' (IOT) are most studied emerging technologies in relation to CE. Kristoffersen et al. (2021a) show that big data analytics capability supports CE adoption and improved organisational performance. Further, blockchain technology supports circular procurement, circular design, recycling, and remanufacturing (Khan et al. 2021b). In the context of supermarkets, de Souza et al. (2021) found that IOT and artificial intelligence facilitate tracking of food deterioration and waste reduction through dynamic pricing and efficient refrigeration and transportation.

The potential of emerging technologies to support CE is evident but implementation of new technologies is far from straightforward. Deficient legislation, lack of government support and poor business-technology alignment are some major external challenges (Dwivedi et al., 2022). Similarly, unfamiliarity with new technologies, lack of management support, high initial investment cost, and lack of compatibility and upgradability are major internal barriers to implementation (Cui et al. 2021: Kumar et al., 2020). Despite these challenges, this emergent stream suggests that emerging technologies can support organisations' goal to achieve circularity and sustainability without sacrificing financial goals.

4. Research trends and gaps

After assessing each stream, we move on to examine extant trends and gaps in business management CE research. We summarise these in Fig. 4 and explore each in more detail through the remainder of this section. This serves as a basis for the following section, which provides an agenda for future research grouped around three overarching research questions.

4.1. Strategy, learning and innovation

At present this stream comprises research in core areas of management literature where CE has emerged as a domain or context in which relevant ideas are being studied. Core perspectives such as dynamic capabilities, organisational learning and innovation have been used to consider CE as a process that firms undertake and a driver of organisational change. Further, various studies have developed performance measures related to strategic implementation of CE. A number of

STRATEGY, LEARNING AND INNOVATION	
Research trends	
- How dynamic capabilities support CE developments	- Absorptive capacity and organisational learning for CE
- Eco-innovation and the role of financial resources	- Performance measures and indicators
Research gaps	
- Microfoundations of DCs supporting CE development	- How do firms develop this absorptive capacity
- How DCs for CE can be developed and cultivated	- Indicators and measures used at an organisational level to monitor the success of CE
- Impact of available financial resources on CE	
CONSUMER BEHAVIOUR & REMANUFACTURED PRODUCTS	
Research trends	
- Consumer attitude toward remanufactured and refurbished products	- Inventory management of remanufactured products
Research gaps	
- Strategies to enhance consumers' acceptance of remanufactured products	- Coordination of circular supply chains for refurbished products from a relational perspective
SUPPLY CHAIN AND CE IMPLEMENTATION	
Research trends	
- Drivers and barriers to a CE and circular supply chains across varying contexts	- Role of technology in the waste management toward
Research gaps	
- Role of contingencies in the transition to CE	- Individual-level perspectives ('human factor') in CE implementation
- Role of secondary stakeholders in the CE initiateves	- Role of different supply chain processes, such as procurement or product design, in facilitating circularity.
- Empirical demonstrations of sustainability, performance and resilience implications of circular supply chains	
CIRCULAR BUSINESS MODELS	
Research trends	
- Value creation in circular business models	- Enablers, barriers and drivers to BM innovation
- Innovation in business models	
Research gaps	
- CBMs impact to supply chain and societal level	- Scalability of innovations
- Strategies and impacts of radical CBM innovations to wider ecosystems	- Development of indicators and measurement systems
- Capabilities role n CBMs towards CE	- Consumption behaviour and CBMs
INDUSTRIAL SYMBIOSIS NETWORKS	
Research trends	
- Resilience and maintenance of ISNs	- Coopetition and performance measurement
Research gaps	
- Lack of empirical studies on industrial symbiosis and their impacts to CE	- Innovations, e.g. material designs in relation with industrial symbiosis
- Performance measurement system for industrial system impacts on CE	- ISN design and composition
EMERGING TECHNOLOGIES	
Research trends	
- Supportive role of three emerging technologies namely big data, blockchain and internet of things.	- Challenges related to implementation of new technologies for CE.
- Largely centered around efficiency of manufacturing operations in organizations.	
Research gaps	
- The business case of technology for circularity, particularly for SMEs	- User perspective on using technology for CE implementation
- Role of reality technologies such as VR, and AR	- Technology's roles in non-manufacturing operations to support circularity is scarce
- Identification of conditions and frameworks underpinning successful implementation of technology driven CE	

Fig. 4. Research trends and gaps.

barriers, enablers and drivers to CE have also been identified. Critically, the need for organisations to develop capabilities based around change has been identified and ideas such as absorptive capacity have been applied to CE cases.

A number of gaps in existing literature exist in this stream. First, the microfoundations of dynamic capabilities for CE warrant more attention. A microfoundations approach is increasingly popular in management literature but its application to CE could yield rich insights. Using an organisational learning lens to study CE across a variety of other streams would provide evidence to support organisations thinking about adopting CE. Absorptive capacity has been studied in a small number of CE contexts but linking this to other areas, such as business

model innovation and understanding of consumer behaviour would assist in making both theoretical and practical contributions. Finally, while sets of measures and indicators for CE at an organisational level have been proposed, in general they lack empirical foundations. Testing, deployment and refinement of such measurement systems would enhance the contribution of this subtheme in future.

4.2. Consumer behaviour and remanufactured products

A deeper understanding of consumer behaviour is integral to realising the full potential of remanufacturing and refurbishing; consumers presently perceive remanufactured products as inferior quality compared to new products. Scholars highlight that CE can be realised only if consumers widely accept remanufactured products. Previous research has largely focused on identifying factors for consumer acceptance of such products. Future research should move on from identification to a more normative approach, suggesting methods businesses can use to increase consumer acceptance. There is also a need for studies that study, for example, consumers' purchase intention for different types of products, including remanufactured, refurbished and recycled products.

Several scholars have investigated characteristics and causes of the bullwhip effect in closed loop supply chains and used simulation techniques to suggest strategies to mitigate impact. A need arises for empirical and qualitative approaches that increase understanding of this phenomenon in different contexts and different supply chain types. Further, it has been proposed that digital technologies may revolutionise remanufacturing; more research at the intersection of remanufacturing and emerging technologies is therefore required. Finally, while prior research has focused on technical and operational aspects of remanufacturing supply chains, organisations also need to manage collaborations between existing and new supply chain members for circular business. Hence, there exists an opportunity to explore from a more relational perspective how to foster collaboration between supply chain members and suggest governance mechanisms for continuous relationships.

4.3. Supply chain and CE implementation

Drivers, barriers and enablers of CE have received considerable attention in this stream. The role of contingency factors, however, such as industry, firm size, cultural differences, and interdependence between drivers, barriers and enablers, have received less attention. Most recent studies take an organisational focus, which may overlook the impact of human factors on CE implementation. Indeed, the success of CE transition is dependent on changing mindsets for all actors within the economic system. Thus, empirical investigations of the significance of behavioural and cognitive factors are required using ideas from managerial and social psychology.

Previous research highlights the significance of collaboration between supply chain members to facilitate CE implementation and circular thinking has become increasingly integrated into supply chain management. Existing studies, however, tend towards single company or dyadic perspectives, neglecting a wider supply network view. Future studies should therefore consider other units of analysis, covering individuals, organisational functions, dyads, triads and complete supply networks. This may require different approaches, such as experimental research or network analysis. Future research should also consider a wider range of stakeholders, such as competitors, NGOs and local communities. Finally, there is limited work on CE system performance measurement, and an opportunity to link this to the wider sustainability and resilience agenda. A particular challenge for future research is to connect performance indicators across the different scopes (Lozano et al., 2021) that have been identified.

4.4. Circular business models

Several researchers have pointed out that innovative business models can bridge organisation- and system-level changes in the CE transition (Boons and Lüdeke-Freund, 2013). Previous research has made several contributions; in CBM development and value creation, CBM innovations and enablers, barriers and drivers for CBM adoption. Researchers suggest phase frameworks for CBM development and value creation and have developed tools to evaluate degrees and modes of circularity. Both start-ups born to CE and incumbents transforming their BMs to CE have been studied.

Research to date has focused on the organisation and overlooks wider network implications. Further research is therefore needed on CBM value creation in connection to wider networks. In particular, more empirical studies on how CBMs reshape supply chain networks and drive transformation to CE would add significant insights.

Similar to other streams, the importance of understanding consumer expectations, identification of customer segments and development of customer relationships in CBM strategies have been identified. Nevertheless we lack a deeper understanding of such behavioural aspects and how to support organisations in changing behaviour, not only of consumers but supply chains and other ecosystem actors towards CE. Further study of CBM value creation and the intersection of CBM strategies, practices and implementation is therefore required. Current CBM research is disconnected from studies in stream 1 that use management theories such as dynamic capabilities and organisational learning. Connecting these areas, along with the use of other perspectives such as systems thinking and network theories, has potential to support transformation to CE.

Existing research has shown CBM innovations as key in transformation to CE but needs to address the connection between innovations, networks and wider collaborative efforts. Value creation and collaboration in radical CBM innovations, their strategies and impacts on wider networks should all be explored. Scalability of innovative CBMs could have a prominent role in the transformation to CE. Finally, different types of performance measurement indicators and systems need to be developed to understand CBMs positive impact on the transition to CE.

4.5. Industrial symbiosis networks

Existing ISN research has focused on theory development via modelling and rarely included empirical data. An opportunity therefore exists to gather empirical data from various sectors and networks, and from different angles to support transformation to CE.

Existing research has highlighted the importance of resilience, where for example diversity and its challenges has been identified, improvements among symbiotic partners has been suggested and resilience indices developed. Future research needs to include empirical studies in various sectors on industrial symbiosis and how they could better boost resilience and promote a systemic shift to CE. Identification of core business processes and practices facilitating synergy development in networks, companies and industries is needed. Further development of resilience performance measurement systems at multiple levels and the role of technology in supporting these systems also require attention.

Prior work suggests the importance of cooperation and performance. Current research neglects linkage management approaches, for example system approaches, organisational and supply chain capabilities or practices or business model development supporting ISNs transformation to CE. A deeper understanding is needed of ISN designs and how CE efforts might reshape networks, thus connecting them to wider

ecosystems. Linking innovation approaches and behavioural aspects could also benefit ISN research to understand better how behavioural change towards CE could be achieved in ISNs.

4.6. Emerging technologies

Emerging technologies possess significant potential for converting circularity principles into reality but a number of challenges exist. A need arises for deeper investigation of the business case of adopting emerging technologies for CE. Many technologies are in the early development phase and their utility not fully understood or realised. A critical lens can support organisations to identify circular opportunities and decide on potential technologies helpful in actualising them. The role of all stakeholders, particularly organisational employees as users of such technologies, need to be explored from a change management perspective. Comprehension of technology affordances and circularity needs alignment can help researchers better understand why some organisations are more successful than others in emerging technology-based CE.

The breadth of technologies studied should also be addressed; the role of virtual reality (VR) and augmented reality (AR) is not well explored in business research. Use of VR has been explored in product design research but its implementation in organisations particularly for eco-design is underexplored. Moreover, reality technologies and consumer behaviour require further study. Both VR and AR possess strong potential in experiential marketing, allowing potential consumers immersion into brand and experience of circular products. This is particularly important given research in other streams identifying negative connotations with remanufactured and refurbished products, even among consumers who are environmentally conscious.

Finally, breadth of application should also be expanded. Circularity should not be limited to manufacturing operations; successful circular transition requires CE be imbued in all operations of an organisation. How emerging technologies can help in non-manufacturing operations such as green human resource management and marketing is underexplored. Similarly organisations operating in the service sector are underrepresented in existing research. Service industries with high carbon footprint such as tourism are already using emerging technologies such AI and VR but a CE perspective is needed to explore the contribution of emerging technology to service industries more widely.

5. Directions for future research

Exploring the trends and gaps above brings out a number of common issues that cut across the six streams our bibliometric analysis identified. In this section we develop three overarching research questions with sub-questions linked back to existing streams. Together these questions provide an agenda for future research designed to accelerate the impact of business and management research on the adoption and proliferation of CE practices. We propose that research needs to move away from identification towards prioritisation and classification to support decision-making, providing richer and more impactful insights for policymakers and managers alike. Further, we suggest that cutting across existing research streams where appropriate is likely to yield deeper insights in future.

Broadly we suggest a normative perspective; rather than reporting existing practices future research should investigate and propose ways in which circular practices can be adopted, measured, monitored and improved. Throughout, using our wider knowledge of business and management research, we examine useful theoretical perspectives that could be introduced or better integrated. We focus these paths for future research around three overarching research questions and related sub-questions arising from the research streams. Table 1 contains our three overarching research questions along with sub-questions labelled by stream(s).

Table 1
Overarching questions and sub-questions by stream.

Questions	Stream
How can businesses instigate societal change for CE?	
Which behavioural factors contribute to the adoption of CE practices?	3
How do CBMs contribute to wider ecosystems and sustainable development?	4
How does the scalability of CBM innovations impact sustainable development?	4
How to measure the performance of a CBM and its impact on societal change?	4
How could management theories support CBM development to systemic shift?	4
How could industrial symbiosis better contribute to systemic shift to CE?	5
How can collaboration boost systemic shift in industrial symbiosis networks?	5
What kind of management theories could boost sustainable development in ISNs and industrial parks?	5
How reality technologies can be utilised to build better marketing strategies for sustainable and remanufactured products?	6
What strategies can organisations employ to thrive in the CE?	
Which mechanisms support the dynamic development of CE?	1
How can firms develop and cultivate dynamic capabilities for CE?	1
What strategies can businesses deploy to increase consumer acceptance of remanufactured products?	2
How CBM value creation can be supported by linking theory-strategy-practice approaches?	4
How have frontline newly established firms and incumbents innovated their CBMs?	4
What are the key organisational capabilities for a fast transformation to CE?	4
How do radical innovations impact systemic shift in ISNs?	5
What can organisations do to reduce vulnerability and disruption in ISN?	5
How organisations evaluate costs and benefits of adopting emerging technology driven CE initiatives?	6
What entails a successful emerging technology driven CE implementation?	6
What processes, practices, structures and measures are needed for organisations to successfully implement CE?	
What is the role of financial resources and constraints in CE?	1
What are measures to evaluate organisations success in CE?	1
Which collaboration and coordination mechanisms should be used in circular supply chains for remanufactured products?	2
Which contingencies may affect the outcome of CE implementation?	3
What is the role played by secondary stakeholders in the CE adoption?	3
How can core supply chain processes support CE?	3
How to measure sustainable, financial and resilience performance of circular supply chains?	3
What are the key circularity indicators and measurements for CBMs?	4
Which structures and practices enhance the activities of ISNs towards CE?	5
What kind of a measurement system could be developed to boost transformation in ISNs and industrial parks?	5
How could new technologies help sustainable development in industrial parks?	5
How can reality technologies support circularity and sustainability in product eco-design development and customer experience?	6
Which factors contribute to the successful adoption of emerging technology for CE implementation in organisations?	6
How to encourage and support employees for adopting emerging technologies to improve circularity in organisational operations?	6

1. How can businesses instigate societal change for CE?

The first overarching question calls for research that helps organisations instigate societal change needed for transition to CE. The need for a systemic shift in the world's economic system needs to be addressed at a societal level. Research needs to address fundamental issues such as ethical, behavioural and philosophical dimensions of CE and how these relate to wider implementation of circular practices. Such research could usefully link the proliferation of CE to political, geographical and societal issues more widely.

CE is advocated as a solution to the overuse of natural resources, climate change and negative environmental impacts (Geissdoerfer et al.,

2017). The majority of scholarly and managerial attention is therefore given to the environmental dimension of sustainability (Geissdoerfer et al., 2018a; Merli et al., 2018; Millar et al., 2019). Current CE research, with its roots in industrial ecology (Bocken et al., 2017), tends to place little emphasis on these social, ethical and philosophical issues. Murray et al. (2017, p. 376) pointedly state that the CE literature is "*virtually silent on the social dimension*". While research has moved on from this point, we identified further exploration of behavioural, cognitive and social aspects as significant opportunities across a number of streams. For example, supply chain management has shown to assist the adoption of circular practices across industries and value systems (e.g. Batista et al., 2018), but consumer acceptance is a threshold condition for any such practices to proliferate (e.g. Agostini et al., 2021; Ayati et al., 2022). Overall, a deeper understanding of consumer perceptions at the societal level is needed.

A broadening of the scope of business management research more generally would help contribute more fully to CE in future. An important recent contribution is a set of eight different scopes (Lozano et al., 2021). Most existing research focuses on organisations and perhaps clusters and sectors, but there is an opportunity to expand the scope used by business management research in future. Another way of expanding the scope is to integrate new concepts, such as sharing economy and collaborative consumption, into CE frameworks (Merli et al., 2018). Further, limited understanding exists about CE's contribution to the wider sustainable development agenda. Studies critically considering CE from the sustainable development perspective and questioning whether and how CE can stimulate economic growth without adverse effects on the environment exist (e.g. Korhonen et al., 2018; Millar et al., 2019) but there is a need for further contributions in this area.

2. What strategies can organisations employ to thrive in the circular economy?

Our second overarching question focuses on strategies organisations can use to prosper in CE. While businesses with circular business models and closed-loop supply chains have an important role to play in the transition to CE, more research is needed. The development of innovative business models is one of the key enablers of a systemic shift (see e.g. Geissdoerfer et al., 2018a; Henry et al., 2020; Kirchherr et al., 2017), Research at this level has already contributed to our understanding of CE and classification of distinct types of CBMs (e.g. Henry et al., 2020; Urbinati et al., 2017) but an opportunity exists to synthesise these areas and move forward. For example, dynamic capabilities, as a cornerstone of strategic management and an emergent area of CE research, may provide a useful theoretical lens to study other phenomena. Revealing competences and capabilities needed to develop and design circular business models, products and services would provide useful guidance for organisations when adopting such practices. Research on dynamic capabilities at cluster, sector and organisation levels, specifically research studying interaction across these levels and their combined effect on CE is therefore necessary. Uncertainty in existing research around scaling up CBMs (e.g. Bocken et al., 2014; Brown et al., 2021a, b; Franco, 2017) could be reduced by combining the sub-themes of consumer acceptance, circular SCM and innovation.

Given that CBMs are a subcategory of sustainable business models (Geissdoerfer et al., 2020: Hofmann, 2019; Pollard et al., 2021), future research would benefit from inclusion of a broader set of elements from sustainable business model research enabling CBMs to become more strongly sustainable business models (see e.g. Geissdoerfer et al., 2018b; Lozano, 2018; Murray et al., 2017; Schaltegger et al., 2016; Upward and Jones, 2016). For example, Lozano's (2018) framework could be helpful, by bringing together organisational approaches, the company system, stakeholders, change and sustainability dimensions and providing a more holistic and systemic approach to the sustainable business model discourse.

Other priorities include the way in which radical innovation could reshape industry networks and ecosystems by closing production loops. Achieving circularity also requires high visibility throughout the network (Khan et al., 2022). Digital platforms powered by emerging technologies may provide one solution (Kristoffersen et al., 2020; Liu et al., 2022), and therefore research building on the opportunities of IOT and other advanced technologies may provide new insights. Future research needs more than a short-term, technology-focused approach; consumer and organisational behaviours as critical factors cannot be neglected. Thorough investigation here would address both development of sustainable processes and how to effectively promote such products to consumers.

Further, consumer acceptance is relevant to CBM research (Elzinga et al., 2020). A deeper understanding of awareness, visibility of circular practices and consumer education would support business model innovation towards CE. Related again to consumer acceptance, are eco-innovation-based products more acceptable to consumers and do they have high diffusion rates? How can organisations leverage improved consumer perceptions and use mechanisms such as crowdsourcing and the sharing economy to increase proliferation of circular practices across the industries and supply chains? The idea of industrial symbiosis also has more to contribute. In particular, the synergy between industrial symbiosis and CE requires more attention (Agudo et al., 2022). Moreover, generating collaboration among a wide range of stakeholders and promoting participation across the supply chain, cross-sectors and value system may provide a foundation for a systemic shift towards CE (Berardi and de Brito, 2021; Ghinoi et al., 2020;). Other areas at this level include the most appropriate business models at different supply chain stages and how these might work together.

3. What processes, practices, structures and measures are needed for organisations to successfully implement CE?

Our third overarching question addresses the need to identify, propose and test processes, practices, structures and measures for the successful implementation of CE. We have already highlighted areas where measurement and monitoring systems should be developed at societal and network levels. The development of such indicators would not only enable data-driven decision-making but also ultimately justify the value of the systemic shift to CE (Kravchenko et al., 2019; Rincon-Moreno et al., 2021; Saidani et al., 2019). Perhaps a more significant contribution in this area relates to the use of innovative technologies to drive the adoption of circular practices. For example, use of artificial intelligence to interpret consumer attitudes and buying behaviours could contribute to the development of CBMs we suggest above. Driving industrial symbiosis through technology and digital platforms for circularity also warrants further investigation.

Emerging technologies such as machine learning and IOT are relevant at the cluster and sector level as well as investigating their detailed implementation in organisations. In addition, development of innovative circular materials from waste and materials compensating non-renewable materials with renewable materials are key in slowing and closing the loops (Sehnem et al., 2022). As with other areas we outline here, performance measurement at multiple levels requires deeper investigation and codification. Assessing, aggregating and synthesising the performance of existing CE practices and developing longitudinal cases of CE implementation would add further value.

5.1. *Wider considerations for future research*

More generally, we propose that answers to these overarching questions should be more firmly theory-grounded than current research shows. This observation is supported by earlier reviews of CE (Sarja et al., 2021; Sehnem et al., 2019). The majority of articles reviewed were not grounded in any management theory and often only contained a review of key concepts and their relation to CE. Some theories are used across more than one stream but, at present studies, in different areas

rarely acknowledge one another. Key domains, such as institutional theory, the resource-based view, dynamic capabilities, organisational learning and business model innovation could provide rich insights into the changes required for a systemic shift in CE but presently take a fragmented approach. To advance CE research, new perspectives can also be drawn from theories used in consumer behaviour, ethics, supply chain management and information systems. Overall, our analysis suggests a more integrated approach to future research adopting a number of explicit theoretical frameworks would help drive interest and provide higher levels of impact of future management research on the proliferation of CE.

6. Conclusions

Our study advances the debate on CE in a number of ways. First, our research provides an overview of business and management work to date on CE and highlights the diversity of studies in different areas of research. We extend the work of Alcalde-Calonge et al. (2022) by investigating in-depth the management side of CE research. Next, we build on prior reviews focused on particular aspects of business and management such as manufacturing (Lieder and Rashid, 2016), innovation (Suchek et al., 2021), circular business models (Ferasso et al., 2020; Hofmann, 2019) and digitalisation (Chauhan et al., 2022) by providing a holistic perspective that shows how these different areas relate to each other. Further, in line with previous studies (Murray et al., 2017) we identify limited and fragmented use of theory in existing research and suggest a number of solutions. Most importantly, we provide a solid foundation for future research, focused around three overarching research questions that provide a platform to accelerate the impact of business and management research on the adoption and proliferation of CE practices in future.

This study is not without limitations. Over the years, bibliometrics has attained the reputation of being an effective and reliable method for mapping scientific literature but is not without disadvantages. First, bibliometrics detects relationships between documents using common citations or references, but referencing in papers might not always be for intellectual reasons such as building and refuting arguments. Indeed, self-legitimation (citing one's own previous work) and selective referencing used to influence the review process can play a part (Mura et al., 2018). Nevertheless, the effects of such behaviours on our final results is likely limited due to the use of the content analysis. Further, bibliographic coupling relies on the similarity of references between papers. Consequently, studies with a long list of references may be over-represented in the dataset. Third, the final results depend partly on technical decisions regarding the threshold used to select the core scientific literature. In this study varying thresholds were tested during the analysis and no major variance was noted in either the structure or content of streams.

Declaration of competing interest

No funding received for conducting this study. Authors have no financial or non-financial interests to disclose. All authors certify that they have no affiliations with or involvement in any organisation or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript. There are no competing interests.

Data availability

Data will be made available on request.

Appendix 1. Summary list of the analysed articles, ordered by paper ID number

ID	Author	Year	ID	Author	Year	ID	Author	Year
Stream 1			86	Chizaryfard et al.	2021	27	Guzzo et al.	2022
47	Sihvonen and Partanen	2018	87	Farooque et al.	2019	28	Brown et al.	2021
48	Aranda-Uson et al.	2020	88	Kazancoglu et al.	2021	29	Pieroni et al.	2021a
49	Sihvonen & Partanen	2016	89	Bai et al.	2022	30	de Arroyabe et al.	2021
50	Sihvonen & Partanen	2017	90	Yamoah et al.	2022	31	Del Vecchio et al.	2022
51	Kiefer et al.	2019	91	Chowdhury et al.	2022	32	Unal et al.	2019
52	Scarpellini et al.	2018	92	Singh et al.	2022	33	Hofmann	2019
53	Khan et al.	2020a	93	Charef et al.	2022	34	Henry et al.	2020
54	Scarpellini, Valero-Gil, et al.,	2020	94	Tura et al.	2019	35	Hofmann & Jaeger-Erben	2020
55	Scarpellini, Marin-Vinuesa, et al.,	2020	95	de Jesus et al.	2019	36	Rok and Kulik	2021
56	Khan et al.	2020b	96	Silva et al.	2019	37	Sehnem et al.	2022
57	Rincon-Moreno et al.	2021	97	Inigo and Blok	2019	38	Franzo et al.	2021
58	Khan et al.	2021	98	Batista et al.	2019	39	Hofmann & zu Knyphausen-	2022
59	Marin-Vinuesa et al.	2021	99	Moktadir, Ahmadi, et al	2020	40	Arranz et al.	2022
60	Marrucci, Daddi, et al.	2022a	100	Ghinoi et al.	2020	41	Donner and de Vries	2021
61	Portillo-Tarragona et al.	2022	101	Dey et al.	2020	42	Pieroni et al.	2021b
62	Rossi et al.	2020	102	Moktadir, Kumar, et al.	2020	43	Fehrer and Wieland	2021
63	Marrucci et al.	2022	103	Barnabe and Nazir	2021	44	Puglieri et al.	2022
64	Dorado et al.	2022	104	Saha et al.	2021	45	Henry et al.	2022
65	Marrucci, Daddi, et al.,	2022b	105	Barnabe and Nazir	2022	46	Brown, Von Daniels, et al.	2021
66	Subramanian & Suresh	2022	106	Galvao et al.	2022	Stream 5		
67	Marrucci et al.	2021	107	Rodriguez-Espindola et al.	2022	120	Martins	2016
Stream 2			108	Dey et al.	2022	121	Fraccascia et al.	2017
1	van Weelden et al.	2016	109	Zhang et al.	2019	122	Martins	2018
2	Mugge et al.	2017	110	Cramer	2020b	123	Fraccascia et al.	2020
3	van Loon & Van Wassenhove	2020	111	Zeng et al.	2017	124	Yazan et al.	2020
4	Dominguez et al.	2020	112	Islam and Huda	2019	125	Fraccascia	2019
5	Ponte et al.	2020	113	Cramer	2022	126	Fraccascia	2020
6	Y. Wang et al.	2020	114	Elia et al.	2020	127	Yazan and Fraccascia	2020
7	de Arquer et al.	2022	115	Kayikci et al.	2021	128	Lutje & Wohlgemuth	2020b
8	van Loon et al.	2022	116	Zhang et al.	2021	129	Lutje & Wohlgemuth	2020a
9	Agostini et al.	2021	117	Agarwal et al.	2022	130	Fraccascia et al.	2021
10	Dominguez et al.	2021	118	Berardi & de Brito	2021	Stream 6		

(continued on next page)

(*continued*)

ID	Author	Year	ID	Author	Year	ID	Author	Year
Stream 3			119	Islam and Huda	2020	131	Khan et al.	2022
68	de Jesus and Mendonca	2018	Stream 4			132	Kristoffersen et al.	2020
69	Batista et al.	2018	11	Urbinati et al.	2017	133	Kristoffersen et al.	2021a
70	Agyemang et al.	2019	12	Franco	2017	134	Kristoffersen et al.	2021b
71	Jabbour et al.	2019	13	Zeeuw van der Laan and Aurisicchio	2019	135	Khan, Zia-ul-haq, et al.	2021
72	Sehnem et al.	2019	14	Franco	2019	136	Khan, Razzaq, et al.,	2021
73	Saroha et al.	2022	15	Guldmann & Huulgaard	2020	137	Pazienza and De Lucia	2020a
74	Chauhan et al.	2021	16	Shao	2019	138	Pazienza and De Lucia	2020b
75	Charef et al.	2021	17	van der Laan and Aurisicchio	2020	139	Y. Cui et al.	2021
76	L. Cui et al.	2021	18	Shao et al.	2020	140	Dwivedi et al.	2022
77	Burke et al.	2021	19	Ferasso et al.	2020	141	Kumar et al.	2020
78	Centobelli et al.	2021	20	Urbinati et al.	2020	142	Trento et al.	2021
79	Agarwal et al.	2021	21	Rovanto and Bask	2021	143	de Souza et al.	2021
80	J. Wang et al.	2022	22	Okorie et al.	2021	144	Liu et al.	2022
81	Dulia et al.	2021	23	Guzzo et al.	2021	145	Kurniawan, Maiurova, et al.	2022
82	Malik et al.	2022	24	Salvador et al.	2021	146	Kurniawan, Othman, et al.	2022
83	Ayati et al.	2022	25	Pollard et al.	2021			
84	Mathivathanan et al.	2022	26	Husain et al.	2021			
85	Cramer	2020a						

CRediT authorship contribution statement

All authors have made substantial contributions to the design of the work, analysis and interpretation of data. All authors have drafted the manuscript and revised it critically for important intellectual content. All authors have approved the version to be published.

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Further reading

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