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Revisiting the Circular Economy Paradox: A Triple Bottom Line Perspective

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ABSTRACT

The Circular Economy (CE) has emerged as a transformative organizational paradigm designed to address the environmental limitations of linear production and consumption systems. Despite its growing prominence, there is ongoing debate about the extent to which CE truly embodies sustainability, particularly whether it adequately addresses the economic, environmental, and social dimensions defined by the Triple Bottom Line (TBL). This study investigates how the TBL approach is addressed in organizational CE research by conducting a bibliometric analysis of 815 academic publications spanning the past two decades. The results reveal a consistent increase in scholarly engagement, marked by a shift from operational-level concerns toward more systemic approaches focused on resource efficiency and innovative business models. However, the analysis also highlights a notable underrepresentation of the social dimension, raising concerns about the comprehensiveness of current sustainability assessments. Based on these findings, the study identifies key research gaps and proposes eight future research directions to advance a more balanced and integrated understanding of CE as a sustainable model.

1 | Introduction

Over the past two decades, Circular Economy (CE) has gained significant momentum as an emerging model designed to optimize material flows, extend product lifecycles, and integrate eco-efficient resources and processes (Korhonen et al. 2018). Governments, corporations, and nonprofit organizations worldwide have advocated for the adoption and enforcement of CE, with the European Union (2020), the Ellen MacArthur Foundation (2020), China's central government (Despeisse et al. 2017; Mathews et al. 2011), and major multinational enterprises such as Apple¹ leading these efforts (Khan, Ahmad, et al. 2021a). Despite this widespread validation, considerable debate continues regarding how, and to what extent, CE aligns with broader sustainability objectives (Di Vaio et al. 2024).

The Triple Bottom Line (TBL) serves as a critical approach for examining sustainability, positing that all three dimensions, economic, environmental, and social, must be addressed to achieve sustainability (Salesa et al. 2022; Witjes and Lozano 2016). Theoretically, the CE concept and the TBL approach appear to be compatible. Both emphasize systemic thinking and resource optimization, yet researchers disagree on whether CE's focus on resource circularity inherently encompasses the social dimension (Choudhury et al. 2023; Kopnina 2019). Whereas some studies treat CE and sustainability as synonymous (Sehnm et al. 2019), others question CE's social impact (Corvellec et al. 2022; Pereira Antunes et al. 2019) or find insufficient empirical evidence to conclude that adopting CE practices always supports all three TBL pillars (Calisto Friant et al. 2020; Prieto-Sandoval et al. 2019).

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Existing literature reviews have explored CE in various contexts, including technical applications, policy frameworks, and design strategies. However, just a few investigate how CE practices fulfill the TBL approach or whether CE, as a “sustainable” model, adequately incorporates social performance alongside economic and environmental gains. Indeed, many reviews and empirical studies highlight improved environmental and economic outcomes (Khan, Ahmad, et al. 2021a; Salesa et al. 2023) but remain inconclusive about the social dimension (Di Vaio et al. 2023). Thus, a key research gap remains: Is CE a fully sustainable model that delivers real economic, social, and environmental impact under the TBL approach, based on existing research?

This article addresses these gaps by systematically screening 815 academic articles published between 1998 and 2023 to examine CE's evolution and its relationship with TBL-driven sustainability. We define “fully sustainable” to mean that research on CE explicitly and consistently examines all three TBL pillars, economic, environmental, and social, and demonstrates evidence of positive, or at least balanced, outcomes across these domains. This approach clarifies whether CE scholarship treats all three pillars uniformly and reveals areas where research attention has been uneven. Consequently, and trying to answer the research question previously exposed, we aim to (1) offer a more nuanced understanding of CE's impact across all TBL pillars, (2) identify reasons behind divergent findings on CE's sustainability, and (3) propose a roadmap for future research that can strengthen CE's contribution to truly sustainable development.

The remainder of this paper proceeds as follows. Section 2 provides the theoretical background of CE and the TBL. Section 3 presents the study's methods. Sections 4 and 5 show the results and a detailed discussion of the findings. Section 6 concludes with the main insights, implications, and limitations of the paper.

2 | Theoretical Background

2.1 | Circular Economy: Origins and Status

Although the CE concept can be traced back to several streams of knowledge and origins, its main foundations received greater academic attention only in the 20th century. By advocating for closed-loop systems that minimize resource input and waste output, CE contrasts sharply with linear “take-make-dispose” models (Eid and Al-Abdallah 2024; Korhonen et al. 2018). Key principles often identified as the “3R/8R/10R frameworks” are based on industrial ecology theories (Ghisellini et al. 2016; McDonough and Braungart 2002).

Over the last two decades, multiple regions worldwide have shifted policies to incorporate CE. China's National Circular Economy Development Plan², emphasizes industrial symbiosis³, resource recovery, and waste reduction to promote an “ecological civilisation” (Luo et al. 2021; McDowall et al. 2017). In parallel, the European Union introduced the Circular Economy Action Plan⁴, the Waste Framework Directive⁵, and the Green Deal, providing regulatory frameworks to bolster

eco-design, extended producer responsibility, and waste prevention (European Union 2020). These policies have accelerated CE adoption across various sectors, from manufacturing to consumer goods.

Nevertheless, as CE practices diffuse globally, scholars highlight existing challenges (Asamoah et al. 2025; Lu et al. 2024). Limited data-sharing mechanisms, inconsistent public policy support, and inadequate financing hinder broad-scale implementation (Bolger and Doyon 2019; Linder and Williander 2017). Furthermore, many analyses remain sector-specific, emphasizing manufacturing and industrial processes and focusing less on service-based industries and integrated supply chains (Liu and Côté 2017; Liu and Bai 2014). These gaps underscore the need for more holistic, cross-disciplinary research that accounts for the multi-dimensional aspects of sustainability.

2.2 | Sustainability and the TBL in CE

CE is widely positioned as an instrument for sustainability, proposing a regenerative system where materials circulate at their highest utility and value (Ellen MacArthur Foundation 2020; Manninen et al. 2018). However, transitioning toward a fully sustainable model requires simultaneously addressing the TBL approach's economic, environmental, and social pillars (Elkington 1998; Walker et al. 2021). While CE's conceptual foundation aligns precisely with an ecological focus, debate continues over how its proposed innovations systematically address social equity and inclusive economic growth (Calisto Friant et al. 2020; Salesa et al. 2025). The CE concept aligns closely with broader sustainability frameworks that emphasize the need for integrated, systemic thinking. One of the most influential models, TBL, was introduced by Elkington (1998) to highlight that sustainable development requires balancing economic prosperity, environmental protection, and social equity. Building on this idea, Elkington et al. (2006) argued that businesses must adopt full-spectrum strategies that go beyond traditional financial performance to create value across all three dimensions. To effectively assess and operationalize such complex models, frameworks are essential tools, as they help structure multifaceted challenges and guide both research and practice (Partelow 2023). Therefore, viewing CE through the lens of the TBL provides a comprehensive approach for evaluating its true contribution to sustainable development. The subsections below examine each TBL dimension in the context of CE.

2.2.1 | Economy and CE

A core assumption behind CE is that closed-loop production can enhance economic outcomes by reducing raw material costs, diversifying revenue streams, and opening new markets for refurbished or remanufactured goods (Ellen MacArthur Foundation 2013; Khan, Marrucci, et al. 2021b). From the cost-effectiveness perspective, reducing reliance on virgin materials often benefits firms operating in resource-intensive industries such as construction, automotive, or electronics (Bressanelli et al. 2020). Designing out waste and implementing take-back

schemes (Linton et al. 2007) can yield more predictable input costs and foster product-service systems that emphasize product longevity over volume sales (Tukker 2015).

Additionally, scholars argue that CE can incentivize technological innovation and drive green entrepreneurship. By embedding resource circularity, firms may discover new services that reduce environmental impacts and generate stable and diversified revenue (Agrawal and Singh 2019; Sahu et al. 2023). This has been particularly evident in manufacturing industries adopting industrial symbiosis, where waste from one process becomes the feedstock for another (Korhonen et al. 2018). Nonetheless, critics note that the transition to CE entails significant up-front investment in machinery, redesign, and workforce training, raising questions about profitability, especially for small and medium enterprises (Linder and Williander 2017). High capital expenditures, uncertain returns, and the need for supportive policy frameworks can stall widespread adoption.

Furthermore, while economic metrics such as profitability, cost reduction, and resource efficiency are often straightforward to measure, the long-term economic benefits of circular strategies can remain ambiguous if one only focuses on direct financial earnings. Some authors emphasize that macro-level economic benefits should be weighed against potential short-term disruptions, including labor market shifts and structural changes in supply chains (de Jesus and Mendonça 2018). As a result, the literature highlights both the promise and the complexity of achieving robust economic performance through circular practices.

2.2.2 | Environment and CE

The environmental dimension of the three TBL dimensions is most strongly associated with CE. By aiming to “close the loop,” CE practices target reduced depletion of finite resources, minimal waste generation, and lower greenhouse gas emissions (Blomsma and Tennant 2020; Geissdoerfer et al. 2023). Designing products for durability and repair fosters multiple lifecycles of use, curbing pollution and material throughput (Di Vaio et al. 2024; McDonough and Braungart 2002). Such closed-loop thinking is also evident in industrial symbiosis, where production can be directly reused as raw materials, lowering net carbon footprints and mitigating ecosystem damage (Domenech and Bahn-Walkowiak 2019; Leal Filho et al. 2024).

Despite these environmental benefits, scholars caution that CE's environmental outcomes depend heavily on practical implementation. For example, rebound effects can occur when improved material efficiency increases overall consumption (D'Adamo et al. 2024; Zink and Geyer 2017). Similarly, overemphasizing recycling rather than rethinking or reducing consumption may shift problems to other parts of the value chain (Ghisellini et al. 2016). Ongoing efforts to measure environmental impacts (e.g., carbon emissions, water footprints, and biodiversity indicators) are challenged by inconsistent data-reporting standards and a lack of shared assessment frameworks (Chen et al. 2020; Moraga et al. 2019). Consequently, while the environmental dimension of CE generally supports the idea of sustainability, a nuanced approach that includes designing for reduced

consumption and standardized, transparent indicators remains necessary.

2.2.3 | Society and CE

The social dimension, widely regarded as the least developed pillar in TBL approach-centered CE literature (Corvellec et al. 2022; Di Vaio et al. 2023; Souza Piao et al. 2023), examines the broader societal outcomes of circular strategies. Proponents suggest that transitioning to CE can stimulate job creation in the refurbishing, remanufacturing, and recycling sectors (Ul-Durar et al. 2023). Likewise, upskilling and educational initiatives may emerge alongside new circular models that require specialised knowledge in product disassembly, quality assurance for reused components, or collaborative consumption platforms (Souza-Zomer et al. 2018).

At a community level, CE practices can promote equitable resource distribution if adequately governed, but such outcomes are not guaranteed (Prieto-Sandoval et al. 2019). Critics point out that improvements in material efficiency do not inherently translate into social well-being (Kopnina 2017). The lack of standardized metrics for social sustainability complicates efforts to demonstrate broader benefits, including healthier working conditions, inclusive community engagement, or fair labor practices (Lozano and Lozano 2024). CE's reliance on global supply chains can also obscure how local communities are impacted by extraction, waste processing, or material flows.

Further research is thus needed to explore how to measure social outcomes and ensure inclusivity and equity within a CE framework (Choudhury et al. 2023). Identifying the mechanisms by which circular strategies intersect with social justice concerns remains underdeveloped. Addressing this gap would provide a more comprehensive foundation for claiming that CE aligns with TBL principles.

2.3 | The Need for Comprehensive Assessment Tools

Despite the growing attention to CE's potential, there is a lack of integrated methods for evaluating sustainability performance across all TBL dimensions (Chen et al. 2020; Chrispim et al. 2023). Much of the existing literature focuses on isolated metrics, such as measuring carbon footprints or cost savings, while providing minimal insight into overlapping societal impacts. Moreover, the diversity of CE applications complicates attempts to develop a universal methodology, as sector-specific characteristics may require tailored indicators. This methodological gap hinders attempts to validate CE's intended TBL outcomes (Liu and Côté 2017; Roos Lindgreen et al. 2022).

To address this shortcoming, researchers recommend designing holistic frameworks that incorporate both qualitative dimensions (such as stakeholder engagement, job satisfaction, and community wellbeing) and quantitative metrics (such as greenhouse gas reductions, resource savings, and economic returns) (Moraga et al. 2019; Voukkali et al. 2023). Engaging public institutions, the private sector, and civil society in co-creating such

frameworks can align stakeholder expectations, improve data transparency, and accelerate the broader adoption of genuinely sustainable practices (Claudio-Quiroga and Poza 2024; Di Vaio et al. 2023).

Taking into account these considerations, this paper adopts a bibliometric approach to investigate how CE literature comprehensively addresses the TBL pillars. By synthesising key themes, trends, and theoretical foundations, we clarify critical knowledge gaps and propose pathways for future research to bolster CE's credibility as a fully sustainable model.

3 | Sample and Methods

3.1 | Sample

In order to obtain evidence on the evolution of the CE concept and gain knowledge on the advancing methods and tools to assess CE from a TBL approach over time, a PRISMA screening procedure was followed (Ferrer-Serrano et al. 2022; Page et al. 2021; Salesa et al. 2022). The bibliometric database selected was the Web of Science Core Collection (SCI-Expanded and SSCI). We selected Web of Science for our bibliometric analysis due to its reliable indexing criteria and focus on high-impact, peer-reviewed publications, ensuring the inclusion of core research outputs with minimal noise. Compared to broader databases like Scopus or Google Scholar, Web of Science provides a more curated and precise dataset, enhancing the robustness of our analysis. The Boolean search was performed on March 18th, 2023. The Boolean terms search consisted of: [(“circular* econom*”) OR (“circular*”) OR (“close* loop* system*”). These terms enable the capture of papers that some consider in their abstracts, titles or keywords the CE model. Expanding the keyword selection to include general sustainability terms such as *sustainab**, *environm**, or *social* would have significantly broadened the dataset beyond the intended scope, potentially incorporating studies that, while relevant to sustainability, do not specifically address CE as a business model. That search returned 341,162 results. Then, we screened by article type documents (319,035 results) that had just been published in business and management areas as we were focusing on organisational perspectives. Note that we have avoided selecting environmental science area as it would have significantly broadened the scope beyond our research objective, incorporating studies that primarily analyze technical, ecological, and natural science aspects of CE, such as material flow analysis, waste treatment technologies, life cycle assessments, and resource efficiency modeling. While these topics are undoubtedly relevant to CE as a broader concept, they do not directly contribute to our investigation of CE as a model within the organizational context. This selection process gave us back 855 papers. After that, we screened by year. We identified the first academic and indexed paper about the CE published by Patterson (1998), so we just finally considered publications between 1998 and 2023 (821 results). In order to guarantee the legibility of the documents, we also filtered by English language (816 results). Finally, we applied the intra-observer screening criteria. We followed this procedure to eliminate articles that did not fit with the objectives of our research. All the titles and abstracts were read to determine with greater robustness the exclusion or inclusion of the articles of our sample. The key criteria

for inclusion were the following: that ‘circular economy’ and its derivatives appear as central pieces of the article. We excluded one paper that did not fit with our research goal⁶. This screening process resulted in a final sample of 815 articles that we analysed in this study (Figure 1).

3.2 | Methods

Bibliometrics are becoming increasingly popular. This is because it is an objective academic literature review method that provides a comprehensive overview of a particular area of research and allows us to glimpse research trends with the scientific rigor that other techniques lack (Donthu et al. 2021). This popularity is enhanced because it is the only methodology that combines quantitative and qualitative procedures, as well as accessibility to scientific databases and specialized bibliometric software. One of the main advantages of bibliometric techniques is their ability to identify key research trends, influential works, and prominent actors within a field, offering valuable insights into the structure and evolution of knowledge domains (Chalmeta et al. 2024; Machado et al. 2024). They provide an objective, replicable framework for evaluating research impact, which enhances the validity and transparency of literature reviews (Donthu et al. 2021; Srisawad et al. 2025). Moreover, the integration of bibliometric tools with large scientific databases and advanced software allows for scalable, data-driven analyses that would be difficult to achieve with traditional review methods, further increasing their efficiency and relevance in contemporary research (Chalmeta et al. 2024; Machado et al. 2024; Srisawad et al. 2025; Zupic and Čater 2015).

According to Noyons et al. (1999), bibliometrics makes use of two main techniques: performance analysis and science mapping. In addition, other enrichment techniques can be used, which go a step further by incorporating network structure metrics (Donthu et al. 2021). The objective of this bibliometric analysis is to show the structural and dynamic aspects of scientific research. The development of computer technologies has allowed this methodology to be improved and positioned as an interesting methodological option to evaluate the structures of science. Performance analysis uses a wide range of techniques, including word frequency analysis, citation analysis, and counting publications by country, university, research group, or authors (Thelwall 2008). Science mapping provides a spatial representation of how different scientific actors are related to one another (Small 1999). Network analysis complements the previous techniques by giving additional information related to centrality and density metrics (Cobo et al. 2011).

To perform the analysis, we have used two different softwares: VosViewer and SciMAT. The combination of both enables us to go deeper in the analysis and to integrate different analytic capabilities. On the one hand, VosViewer, developed by Van Eck and Waltman (2010) at the Centre for Science and Technology Studies, Leiden University, is a widely used tool for constructing and visualizing bibliometric networks, such as co-authorship, co-citation, and keyword co-occurrence networks. Its capability to handle large datasets and produce interactive, visual maps makes it ideal for scientific mapping. On the other hand, SciMAT (Cobo et al. 2011) is an open-source software designed

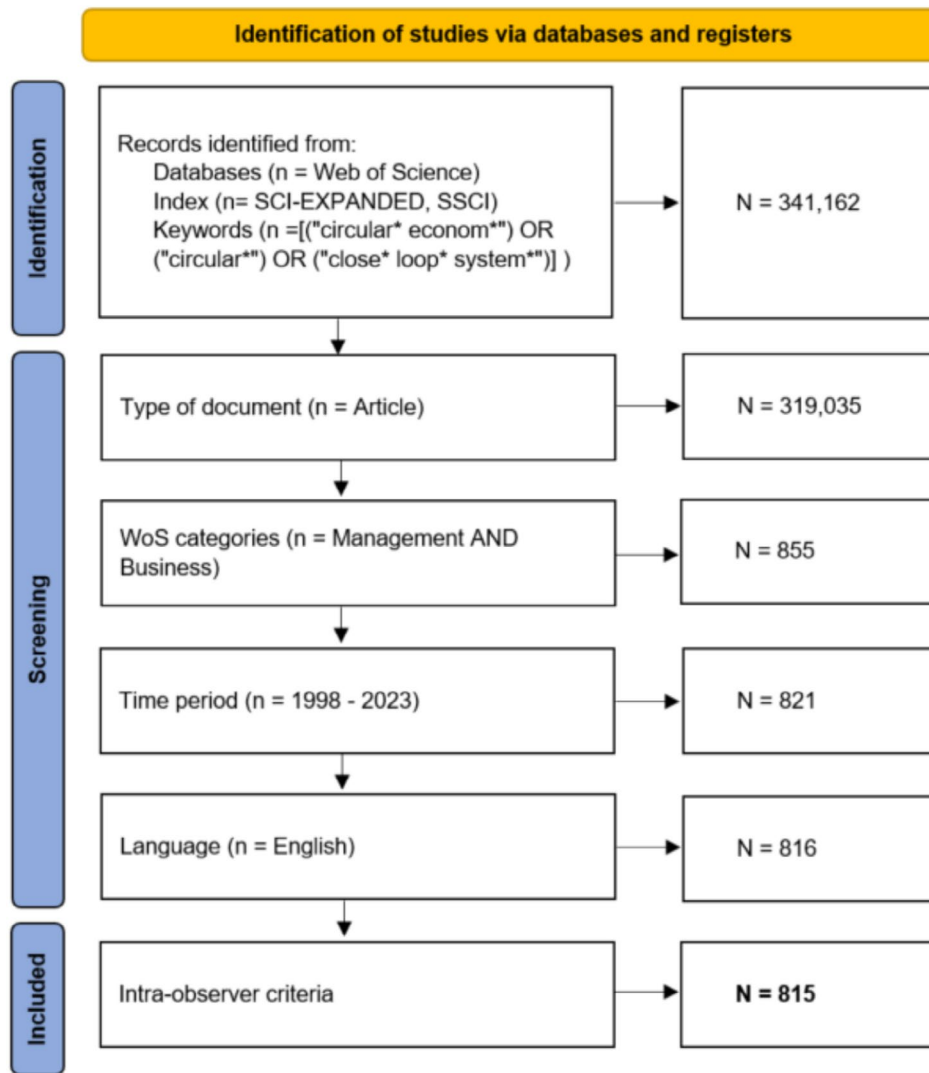


FIGURE 1 | Flow chart diagram based on the PRISMA.

for science mapping analysis with a focus on tracking the evolution of research topics over time, cluster detection, and strategic diagrams. Both tools are publicly available, with VosViewer accessible via its official website and SciMAT distributed through open-source repositories, ensuring accessibility for replication and future research.

4 | Results

This section presents the results of our three-step analysis. First, our performance analysis identifies the most influential journals, authors, and documents within the field of CE. After that, we present the science mapping results. Finally, we use network metrics to enrich the analysis.

4.1 | Performance Analysis

The CE field is a recent research topic that has gained attention in the last years (see Figure 2). Specifically, in 2018, the number of publications tripled that of the previous year and has been growing steadily ever since, reaching the maximum number

of articles ($n=76$) and citations ($n=5519$) in 2022. The explanation can be found in 2015⁷ when the European Commission adopted its first CE action plan. It included measures to help stimulate Europe's transition towards a CE, boost global competitiveness, foster sustainable economic growth, and generate new jobs. The Circular Economy action plan established concrete and ambitious actions, with measures covering the whole life cycle, from production and consumption to waste management and the market for secondary raw materials, and a revised legislative proposal on waste. On March 4th 2019, the European Commission adopted a comprehensive report on the implementation of the action plan. The report presents the main achievements and sketches out future challenges to shaping our economy and paving the way towards a climate-neutral CE where pressure on natural and freshwater resources, as well as ecosystems, is minimised.

Figure 2 seems to point out that the tendency is going to continue the same way. As an illustration, different organizations are still making a call to investigate the implementation of CE in modern societies further. In September 2023, the WWF recognized that the German economic model is in crisis based on high energy prices, fragile supply chains, and geopolitical uncertainties⁸. Also,

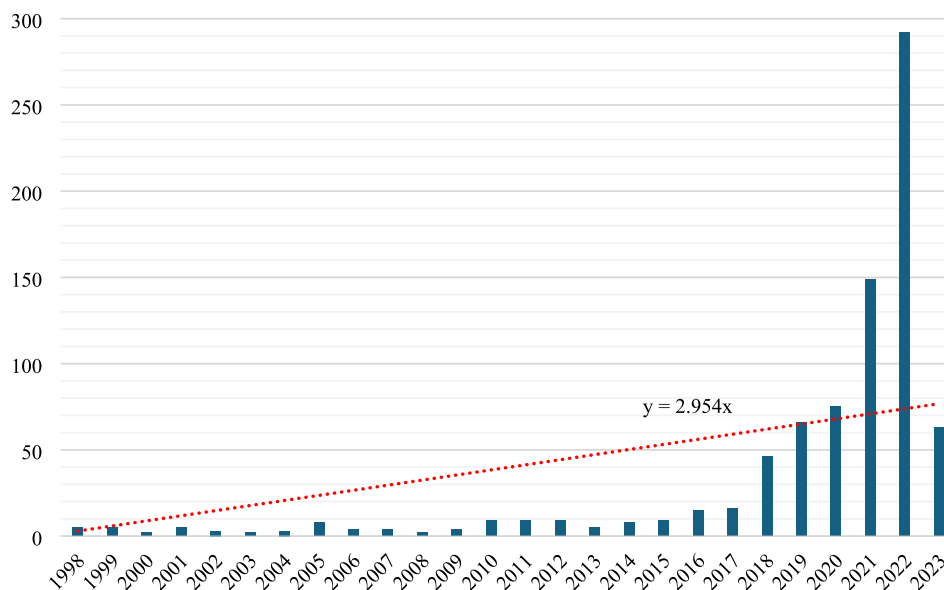


FIGURE 2 | Evolution of the “Circular Economy” research area (1998–2023).

firms from the automotive industry, due to their specificities, have begun a competitive race in the CE transition. The Renault group has opted for an individual system to manage end-of-life vehicles with the objective of reducing its impact on resources through recycling and reusing materials⁹. On its part, Stellantis has inaugurated its first CE Hub (investment of €40 million and 550 employees) in Turin, Italy, with the purpose of reaching the target of becoming a carbon net zero corporation by 2038¹⁰. Oliver Zipse, Chairman of the Board of Management of BMW AG, said, “The future of the BMW Group is circular. To achieve this, we are applying the principles of the CE even more systematically throughout the entire lifecycle of the future vehicle generation¹¹.”

However, although the Circular Economy action plan from the EC boosted the relevance of CE, Europe is not the only region actively promoting CE principles, as various initiatives worldwide reflect the global momentum of the CE transition. For example, in China, the Circular Economy Promotion Law (Jintao 2008) and subsequent policies, including the CE-oriented 13th Five-Year Plan, have made the country a global leader by integrating CE into industrial, urban, and environmental planning. Pilot zones in cities like Shanghai and Tianjin demonstrate how large-scale industrial symbiosis and waste reduction practices can be achieved. Similarly, Japan has been at the forefront of CE adoption through its Basic Act for Establishing a Sound Material-Cycle Society (2000). This policy framework focuses on waste minimization, recycling, and extended producer responsibility, with significant impacts across sectors like electronics and automotive manufacturing. Laws such as the Home Appliance Recycling Law and Automobile Recycling Law have provided robust mechanisms for resource recovery, positioning Japan as a model for efficient material reuse. In Australia, the National Waste Policy: Less Waste, More Resources Australian Local Government Association (2018) reflects a strong commitment to CE, with strategies aimed at promoting recycling, reducing single-use plastics, and fostering innovation in waste management. The Recycling Modernisation Fund (2020) which invests over AUD \$250 million, has enhanced the country's capacity to process and repurpose waste materials domestically,

reducing dependency on international recycling markets. Finally, in the United States, CE efforts have been driven by decentralized initiatives from corporations, local governments, and partnerships with international organizations. For example, Google's Circular Google Program emphasizes product longevity and resource efficiency, while Walmart's Circular Connector Initiative connects innovators to promote scalable CE solutions across supply chains. Additionally, the NextCycle Colorado Initiative exemplifies regional-level CE development through public-private partnerships targeting the reuse of materials and secondary market development.

These initiatives, both within and outside Europe, underscore the global nature of the CE transition. As CE research gains momentum, it is critical to consider how global policies and practices interact to shape knowledge production and cross-border innovation in circular systems. Thus, the observed growth in scientific output is likely driven not only by European policies but also by significant advancements and investments in CE worldwide.

The sources where this research has been published are highly widespread: the 815 articles in this study have been published in 152 different journals. The more frequent journals (10 or more papers) are shown in Table 1. Most of them are leading journals in the business and management fields (the 2021 impact factor [IF] of 87% of the Top 15 journals exceeds 5.0, with an IF average of 7.5). Among the top 15, four journals exceed 1000 citations. This analysis suggests the existence of a strong heterogeneity of journals that focus on topics such as strategy, operations, marketing, or environment, among others. This implies that it is a discipline that receives interest from different fields.

4.2 | Science Mapping

This section conducts a science mapping analysis of the bibliographic material to characterize the subject matter further. Science mapping, as described above, provides a spatial and representative view of how the different actors in a

dynamically changing area of knowledge relate to each other (Small 1999). Intending to overcome the limitations of bibliometrics, we apply a combination of techniques (co-citation and co-authorship) that enable us to offer a complete overview of the subject.

We used VOSviewer to analyze patterns of co-authorship and co-citation. VOSviewer calculates the *Total Link Strength* (TLS), which measures the total strength of the links of an item with other items (Vallaster et al. 2019). Subsequently, the analysis is complemented by using SciMAT (co-occurrence) for the study of evolutionary dynamics, cluster identification, and analysis of centrality and z.

4.2.1 | Co-Authorship Analysis of CE

Co-authorship analysis measures the most productive set of documents and identifies units with the highest degree of joint publications, that is, the dynamics of collaboration (Tahamtan et al. 2016). The study of co-authorships among academics contributes to richer scientific findings, helping to improve the understanding of a research area.

Figures 3 and 4 represent the co-authorship network of the CE field. In other words, these networks reflect the interaction between authors (Figure 3) and countries (Figure 4). The position of the Yellow Cluster, which acts as a central piece of the

TABLE 1 | Top 15 journals by TP.

		TP	TP (%)	IF ₂₀₂₁	TC	TC/TP
1	Business strategy and the environment	164	20.12	10.801	3888	23.71
2	Technological forecasting and social change	54	6.63	10.884	1442	26.70
3	European journal of operational research	48	5.89	6.363	1125	23.44
4	Journal of business research	48	5.89	10.969	874	18.21
5	Journal of enterprise information management	29	3.56	5.661	342	11.79
6	Management decision	28	3.44	5.589	1180	42.14
7	Corporate social responsibility and environmental management	22	2.70	8.464	409	18.59
8	Amfiteatru economic	21	2.58	2.304	230	10.95
9	International journal of logistics-research and applications	21	2.58	5.992	221	10.52
10	International journal of logistics management	20	2.45	5.446	180	9.00
11	Operations management research	19	2.33	7.032	147	7.74
12	Industrial marketing management	18	2.21	8.890	332	18.44
13	Journal of manufacturing technology management	12	1.47	8.144	483	40.25
14	Journal of fashion marketing and management	10	1.23	4.184	296	29.60
15	Supply chain management—an international journal	10	1.23	11.263	332	33.20

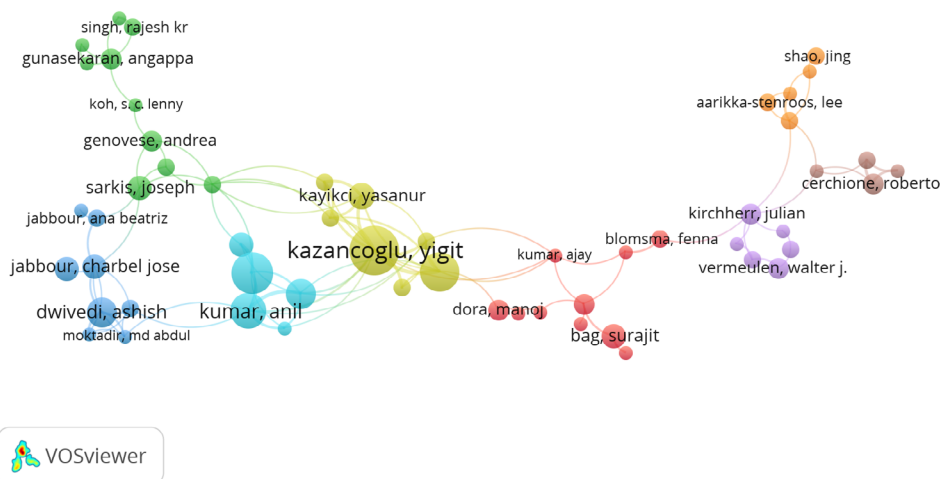


FIGURE 3 | Co-authorship network (researchers). *Minimum number of documents per author = 3; among the 92 authors that fit this condition, 55 were interconnected, forming 8 clusters with 104 links (TLS = 177).

network, is particularly interesting, as it is the connector of the rest of the clusters. The geographical location of researchers has a certain influence on the cluster's formation. It can be seen from the clusters that proximity increases the incentives to collaborate. For example, researchers in Germany, the Netherlands, and Denmark tend to collaborate. Also, French and Spanish academics collaborate. The same happens with Sweden and Finland. In this sense, we can think that cultural barriers are important determinants of collaboration, as all these aspects are also identified in research project participation, where the groups of countries previously mentioned tend to collaborate and execute circular-related investigations together. In the case of the research collaborations between Germany, the Netherlands, and Denmark, some projects such

as RE-NEW, CBI-NE, and Circular Buildings foster collaboration among those countries. France and Spain collaborate in programs like INTERREG SUDOE or RICEPI, and Sweden and Finland, with projects mostly headed by the VINNOVA agency. All these countries have some aspects in common: proximity in physical and cultural aspects brings more confidence and support, which fosters group work among researchers due to the low degree of barriers and aspects that hinder the development of networks.

4.2.2 | Co-Citation Analysis of CE

Co-citation analysis identifies occurrences where two articles are jointly cited by one or multiple articles (Shiau et al. 2017). In a co-citation network, two publications are connected when they co-occur in the reference list of another publication (Donthu et al. 2021). The major benefit of this technique is to identify the most influential items. In contrast, since it is based on the number of citations and accumulating citations takes time, this technique has the disadvantage that it is not able to identify emerging research niches or research trends. Through this analysis, it is possible to analyze which of the main relationships and articles have been used as a basis for most of the research, which allows us to understand the direction that research has taken in the field of CE.

Assuming that co-citation helps to identify the most influential documents in a field, we can conclude that CE is a young discipline that started to become influential between 2016 and 2020. During this period, the most influential papers were published. In this sense, six different clusters integrate the whole network, setting the basis of the CE stream of research (see Figure 5 and Table 2).

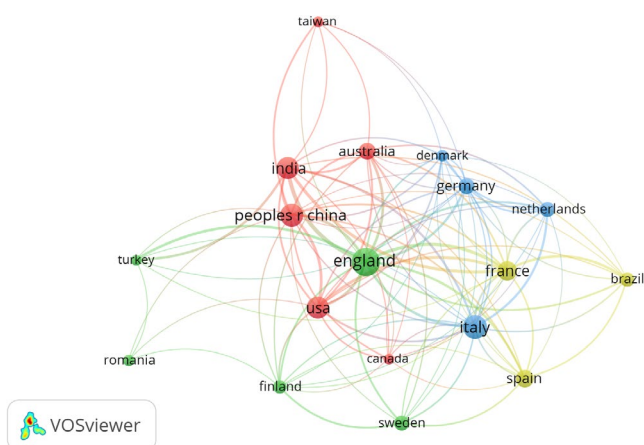


FIGURE 4 | Co-authorship network (countries). *Minimum number of documents per country = 20; 18 countries were interconnected, forming 4 clusters with 105 links (TLS = 469).

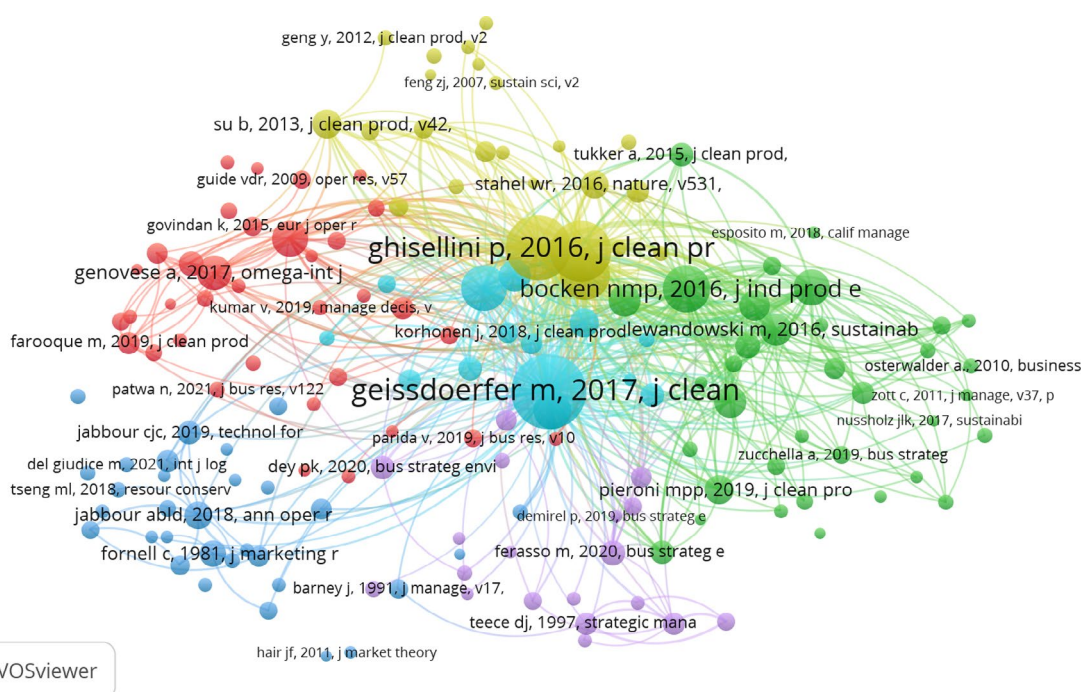


FIGURE 5 | Co-citation network. *Minimum number of citations of a cited reference = 20; 158 articles were interconnected, conforming to 6 clusters with 10,645 links (TLS = 46,678).

TABLE 2 | Co-citation clusters.

Article	Journal	Links	TLS	Citations
Cluster 1. Supply chain management				
1 Govindan, K., & Hasanagic, M. (2018).	International journal of production research	156	1262	904
2 Genovese, A., Acquaye, A. A., Figueroa, A., & Koh, S. L. (2017).	Omega	151	946	1198
Cluster 2. Circular business models				
1 Bocken, N. M., De Pauw, I., Bakker, C., & Van Der Grinten, B. (2016).	Journal of industrial and production engineering	157	1802	2837
2 Linder, M., & Williander, M. (2017).	Business strategy and the environment	153	1443	881
Cluster 3. Industry 4.0				
1 Lopes de Sousa Jabbour, A. B., Jabbour, C. J. C., Godinho Filho, M., & Roubaud, D. (2018).	Annals of operations research	149	860	799
2 Jabbour, C. J. C., de Sousa Jabbour, A. B. L., Sarkis, J., & Godinho Filho, M. (2019).	Technological forecasting and social change	144	632	357
Cluster 4. CE conceptualisation				
1 Ghisellini, P., Cialani, C., & Ulgiati, S. (2016).	Journal of cleaner production	157	2407	4960
2 Kirchherr, J., Reike, D., & Hekkert, M. (2017).	Resources, conservation and recycling	157	2173	5110
Cluster 5. BSE				
1 Dey, P. K., Malesios, C., De, D., Budhwar, P., Chowdhury, S., & Cheffi, W. (2020).	Business strategy and the environment	149	798	178
2 Ferasso, M., Beliaeva, T., Kraus, S., Clauss, T., & Ribeiro-Soriano, D. (2020).	Business strategy and the environment	154	849	286
Cluster 6. CE implementation				
1 Geissdoerfer, M., Savaget, P., Bocken, N. M., & Hultink, E. J. (2017).	Journal of cleaner production	157	2741	5652
2 Lieder, M., & Rashid, A. (2016).	Journal of cleaner production	157	1725	2295

The results of the table show the main communication channels and theories on which the CE has focused its development. The first and second clusters show how the importance given to supply chain management and circular business models begins to gain relevance. This makes much sense when it is observed that the integral transformation of the traditional business model to a circular one requires, in the vast majority of cases, the integral transformation of the supply chain for the reintegration of waste and the establishment of reverse logistics to recover materials that can be incorporated. Cluster 3 bases the development of the CE on all the innovations that Industry 4.0 incorporates and that can facilitate the incorporation of the CE from the point of view of those aspects that are still not properly developed. Cluster 4 and Cluster 6 show how it is still an important topic that is still being widely researched, both the conceptualization of the circular business model, whose universal definition is still difficult to define today, and the implementation, which is significantly

complex as it is related to the sectors of activity and the degree of modeling of the same in order to implement this new production and business model. Finally, Cluster 5, BSE, refers to the high degree of importance that *Business Strategy and the Environment* journal has had for the dissemination of knowledge related to the CE, given the significance of its publications, as can be observed in Table 2.

4.3 | Network and Cluster Analysis

We used SciMAT to analyze the topics and thematic areas of the 815 papers included in this study. The initial content analysis counted 2171 words extracted by the software from the titles and keywords of the complete sample. These words were subsequently evaluated and standardized by the research team in a laborious process. For instance, words like “MNEs”, “MNCs”, and “multinationals” are

judged to be the same construct. After the standardization and grouping process, 172 unique keywords were retained. To analyze the evolutive dynamics of the field and follow the previous literature, we break our sample into four periods. To balance our sample in terms of the volume of documents, we included 8 years in the first period, three in the second, and two in the rest.

4.3.1 | Strategic Diagrams Evolution

Following Cobo et al. (2011), Figure 6 represents in different strategic diagrams the evolution of the area considering a three-dimensional space: centrality (X-axis), density (Y-axis), and the average number of citations (size of the themes).

Centrality measures the degree of interaction of a network with other networks (Callon et al. 1991) and can be defined as $c = 10 \times \sum e_{kh}$ where k is a keyword belonging to a given topic, and h is a keyword belonging to other topics. Centrality measures the strength of external ties to other topics. We can read this value as a measure of the importance of a topic in the

development of the entire research field. Density measures the internal strength of the network (Callon et al. 1991) and can be defined as $d = 100 \left(\frac{\sum e_{ij}}{w} \right)$, with i and j keywords belonging to the theme and w the number of keywords in the topic. Density represents a measure of the cohesiveness of a network, and it is commonly measured as the proportion of existing connections over the total number of possible connections in a network.

Four kinds of themes (clusters) can be identified according to the quadrant in which they are located (Cobo et al. 2011). Themes located in the upper-right quadrant can be considered as the *motor themes*. They are related externally to concepts applicable to other themes that are closely related. Those themes are well developed and important for the structuring of the research field. Themes in the upper-left quadrant are very *peripheral and specialized*, so they have marginal importance for the field. Themes in the lower-left quadrant represent either *emerging or disappearing* themes. Finally, themes in the lower-right quadrant are important for the field but are not developed enough. Thus, this quadrant groups *transversal and general basic* themes.

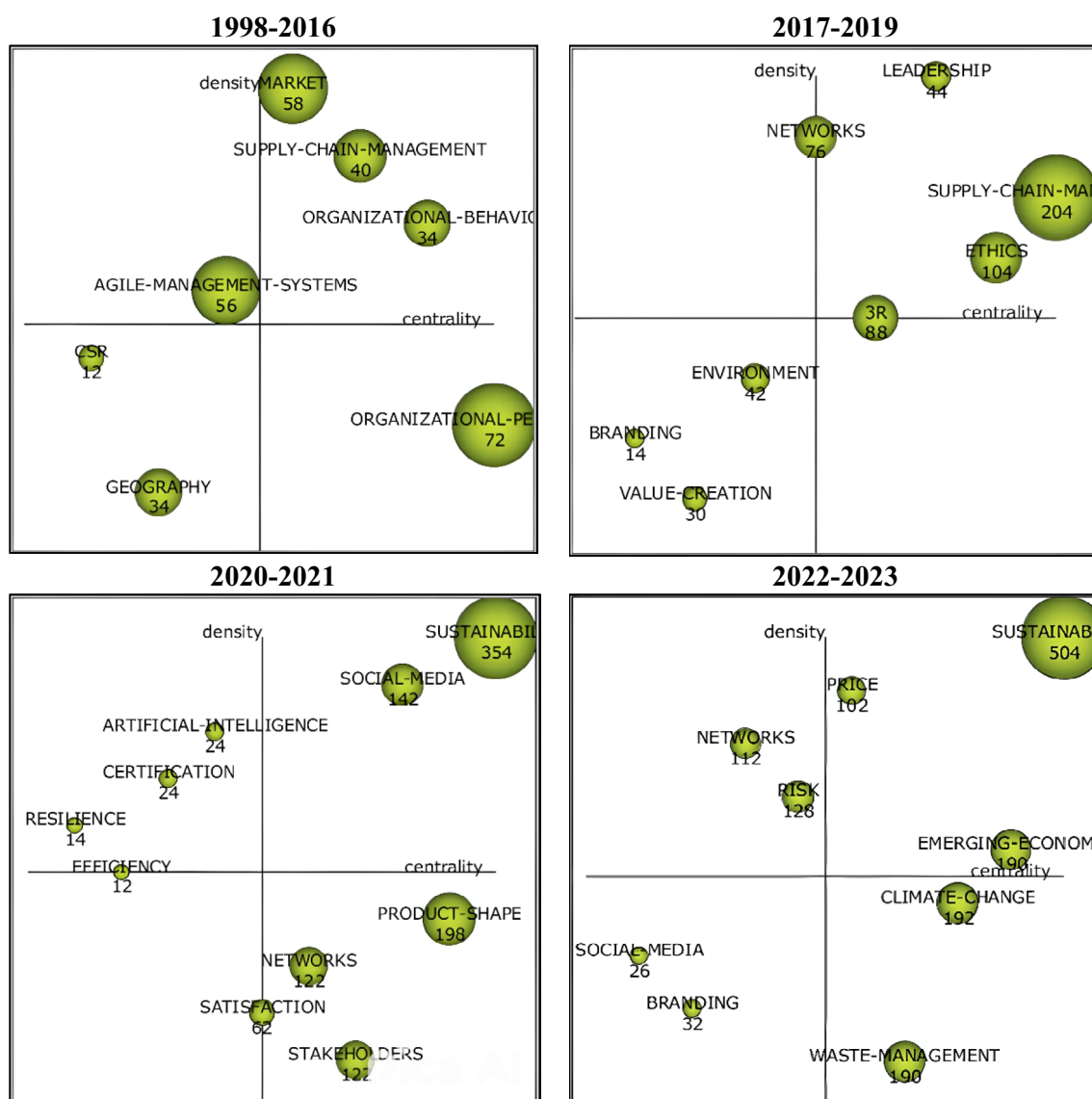


FIGURE 6 | Strategic diagrams evolution. Bubble size is determined by the number of documents.

The first period (1998–2016) represents the emerging years of CE, corresponding to its most operational and organisational-focused perspective. Three concepts are identified as motor themes (market, supply chain management and organisational behaviour) and two as emerging themes (Corporate Social Responsibility (CSR) and geography). These topics must be considered as CE is still under theoretical development and has a low level of development as a model. This period looks for (1) determining the degree to which markets are prepared for a change in their model, (2) identifying what changes should take place in the system (especially at the organisational level within the structure and composition of the supply chain and the incorporation of reverse logistics), as well as for (3) the design of adaptation strategies for CE implementation. At the same time, the emerging topics show alternative perspectives where researchers were focused, such as the perspective of CSR as the main potential for the development of the CE and the degree to which CE models were being developed worldwide.

During the second period (2017–2019), although supply chain management is still present as one of the principal axes, seven new topics appeared. Among them, networks, leadership, ethics, and 3Rs are motor themes. At this point, it is perceived how the CE evolved since it started to seek the study of consequences generated by CE, such as the correct application of the 3Rs, the establishment of networks to strengthen the development of CE, or even the role of the leader in the transition to circular models. In addition, the environment, branding, and value creation appeared in the emerging cluster. Researchers started to contemplate CE not only as an operational strategy (clearly identified in the first period) but also as an integrative model that can support environmental sustainability needs while creating value for the firm. In this sense, we see how the CSR topic was still not a central frame in developing the circular model, as studies are more focused on the climate emergency. This period could correspond to a development stage of the CE state of art.

Third period (2020–2021). Ten themes are identified but with a different distribution compared to the previous period. It is relevant to notice that there are no emerging themes in this period, allowing us to understand that this period could correspond to the valley stage of the CE literature stream. Two concepts are considered motor themes: sustainability (very strong density and centrality) and social media. This period reflects how the new environmental sustainability perspective is becoming the basis for the development of the CE, given that most of the studies at this time are all based on determining whether the circular model is really sustainable and meets the required characteristics to reduce the environmental, social, and economic impact of industries. At the same time, it is seen how the circular production model is being profiled and specialised (with a particular focus on the role of digital technologies), with aspects related to the shape and components of products appearing to promote the proper use of materials and components. Finally, it is observed how studies are beginning to be carried out on the first certifications that emerge on the CE and the efficiency that it can achieve, given that there are already companies and countries that have begun to support and develop through various measures the adoption of the CE and the transition from the traditional model. In this sense,

during this period, we are starting to contemplate how there is a concern over stakeholders' satisfaction with organisations and how certifying CE could arise as a tool to achieve it (systemic perspective).

Finally, nine research themes can be identified in the fourth period (2022–2023). Apart from sustainability (continues from the previous period as a stable theme with the highest number of average citations), price and emerging economies clusters represent the motor themes, highlighting the current concern in academia about barriers to CE implementation (increase in the price of sustainable products and the willingness of consumers to pay more for more sustainable products) and about the potential CE implementation in developing territories. In addition, it is relevant to mention how climate change and waste management appear in the transversal theme of the discipline, stressing the urgency of the worldwide challenge and the main force to transition to a new model. In this period, we again see an evolution of the discipline to a more critical and conscious perspective of CE.

4.3.2 | Longitudinal Overview

Figure 7 provides a preliminary picture of the evolution of the field, interconnecting the findings of the previous section. Each column represents a period and identifies a series of nodes that are groups of keywords. These keywords are connected through links of different types. The continuous links represent high intensity between terms. In addition, the thicker the links, the higher the co-occurrence of keywords. The discontinuous links represent the relation between the concepts with lower intensity. Finally, the nodes' size is determined by the H-index. Note that accumulating citations requires time, so the size of the bubbles is sensitive to this, which explains their greater size in the second and third periods.

This first stage (1998–2016) encompasses a significant evolution in CE research. While the concept was defined earlier, CE gained development and recognition in this period. It is remarkable to highlight some key points academia was concerned with as research from this timeframe is essential to lay the foundations for the incorporation of CE in companies (Bocken et al. 2016; Hahn et al. 2015): CE is starting to be contemplated as a helpful element for organizational performance (Franklin-Johnson et al. 2016; Zhu et al. 2010) and organizational behavior (Linton et al. 2007). Several specific circular transformations are starting to be developed, as traditional business models require adaptations such as integral changes in the supply chain (Sauvé et al. 2016) and the incorporation of agile management systems to emphasize collaboration, adaptation, and continuous improvement (Stubbs and Cocklin 2008). Moreover, as this new business model rises in this stage as a possible substitution for the linear model, researchers started to test the willingness of markets to change their commercial strategies and the impact that this new model would have (Bocken et al. 2016; Geng et al. 2013; Stahel 2016).

It is from the second period (2017–2019) that CE is firmly supported by public (EU, China) and private institutions (EMAF) as an actual alternative to the linear model (Lüdeke-Freund

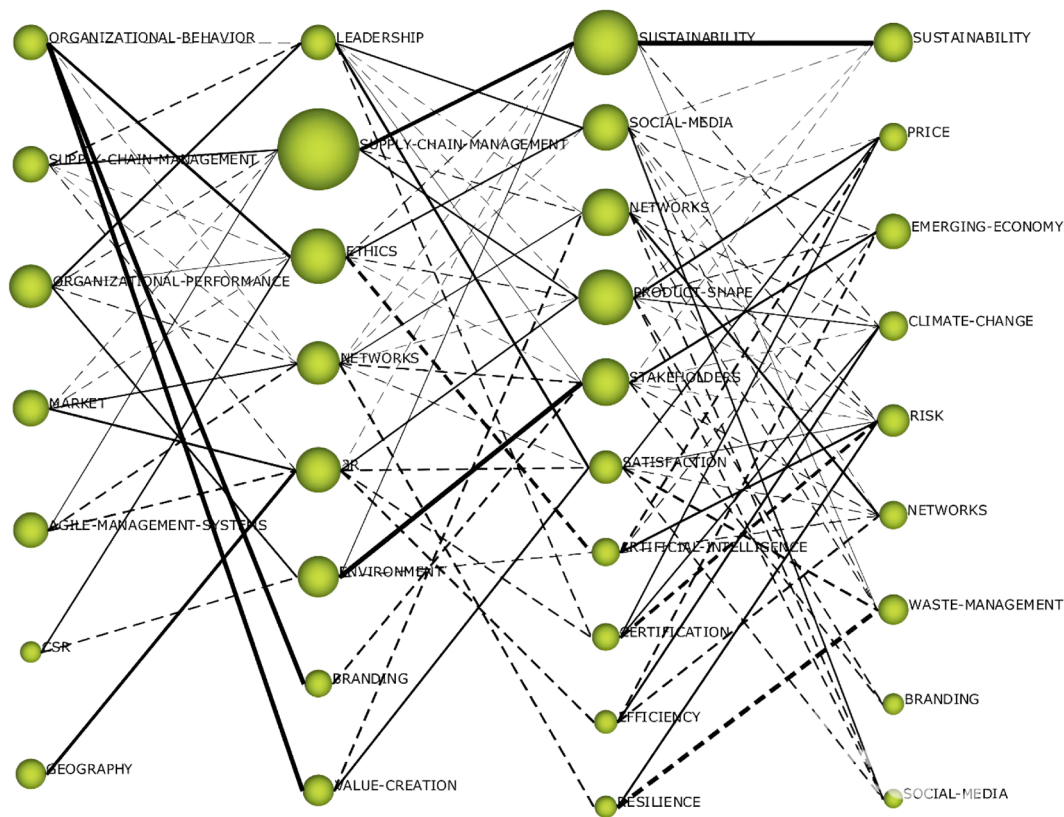


FIGURE 7 | Longitudinal overview of the CE clusters. Bubble size is determined by the H-index.

et al. 2019). As a result of this progress, the study of supply chain transformations is increasing exponentially, along with the further development of the study of practices necessary for the transition to a circular model such as the 3Rs (Barreiro-Gen and Lozano 2020). In turn, aspects that are beginning to be necessary for entities are shown, such as aspects of value creation, branding, and ethics, accompanied by the figure of leadership so that the transition can be effective and followed by the entire organisation (Sehnm et al. 2019). Finally, networking is mentioned when analysing the limitations that may arise for corporations to develop this model individually, making it necessary to establish networks to achieve efficient development.

In the third stage (2020–2021), the research moves to a more detailed level, and more specific technical and economic aspects are considered. The concern for the model's sustainability stands out, especially through efficiency and environmental impact (Harris et al. 2021). It is again observed how the importance of the constitution of work networks is reaffirmed to develop the model efficiently, and the role that stakeholders occupy begins to be specifically defined. It is at this moment when the need to incorporate and develop efficiency matters (De Pascale et al. 2021) in the application of the model and the possible definition of certification channels (Khan, Ahmad, et al. 2021a) to ensure correct implementation of the CE also begins to be glimpsed. In addition, new technical aspects also appear that are beginning to be important in the development of the CE, such as Artificial Intelligence (Nowakowski et al. 2020) and product shape (Hapuwatte and Jawahir 2021).

In the last period (2022–2023), it is observed how the research topic has settled in detail, and the topics that were initially defined generically have now given way to more specificity, and even certain critical voices are observed depending on the research area. As previously seen, CE sustainability studies continue to play a particularly relevant role in research, and there is a need to build networks for its development. However, aspects appear that have not been taken into account so far, and that speak of the profiling of the model for its inclusion through aspects such as price (Salesa et al. 2022), influence on climate change (Hu et al. 2022) its role in waste management (Chioatto and Sospiro 2023) and the use of materials (Nodehi and Taghvaei 2022). It is also noteworthy how the role that CE is taking on as an emerging economy is beginning to be taken into account thanks to the support of institutions and its gradual incorporation both completely and through various specific practices (Fernandes Aguiar and Jugend 2022; Salesa et al. 2023). In turn, research is beginning to assess the risks of the model, and that exerts, for the first time since its rise, critical voices both as an economic model and at the level of promoting sustainability (Corvellec et al. 2022; Hu et al. 2022), based especially on the lack of measures and indicators to determine the true impact of CE as an economic model (Greene et al. 2024; Jerome et al. 2022; Kirchherr 2022).

5 | Discussion

The study reveals how CE research development is still limited, especially in the social perspective of the sustainability

framework, despite the public and private stimuli it is receiving. Therefore, it is important to emphasize the main avenues that have been covered and identify the limitations and barriers that still prevent establishing a real and well-defined connection of the CE as a business model from the TBL perspective.

5.1 | Future Research Avenues

Figure 8 shows eight critical lines of inquiry that emerged from reviewing works published in 2023. Below, we synthesize and justify these avenues by connecting them directly to the literature and highlighting their importance for future scholarship and organizational practice.

5.1.1 | Emerging Economies

Emerging economies stand at the confluence of economic growth, resource limitations, and environmental stressors. As such, CE strategies in these regions must be context-sensitive (Gahlaut et al. 2024; Sehnem et al. 2021). Future studies are expected to develop adaptive models that reflect local governance structures and infrastructural constraints. Leadership and organizational transformation are pivotal in embedding CE principles within small and medium enterprises. Leadership styles and management control systems that encourage circularity are increasingly being investigated (Cheffi et al. 2023; Soni et al. 2023). Additionally, innovation ecosystems and collaborative networks are crucial for accelerating circular transitions, particularly through technology transfer and knowledge-sharing mechanisms (Kuzma and Sehnem 2023). The optimization of

sustainable supply chains and circular models will likely become a priority, with research focusing on designing resilient systems that reduce waste and improve resource efficiency (Gahlaut and Dwivedi 2024).

5.1.2 | Supply Chain Management

The transition to circular supply chains demands attention to ethical leadership, operational capabilities, technological integration, and systemic adaptability. Ethical leadership plays a central role in fostering trust and accountability within circular supply chains (Agyabeng-Mensah et al. 2023; Gahlaut and Dwivedi 2024). Investigating its impact provides valuable insights into navigating sustainability complexities. Concurrently, operational-level capabilities and the deployment of Industry 4.0 technologies are instrumental in realizing regenerative cycles (Bag and Rahman 2024; Faisal 2023). Big data analytics has emerged as a key enabler, allowing for real-time performance evaluation and strategic decision-making (Berberoglu et al. 2023; Riggs et al. 2023). Furthermore, circular supply chains function as complex adaptive systems (Ciccullo et al. 2022), necessitating research on coordination mechanisms and emergent system properties.

5.1.3 | Public Policy

Given the urgency of environmental challenges, public policy must evolve to facilitate CE adoption through comprehensive, adaptive, and culturally informed strategies. Evaluating CE policy implementation is crucial. Studies should assess policy effectiveness by measuring environmental and economic impacts while incorporating organizational learning dynamics (Behl

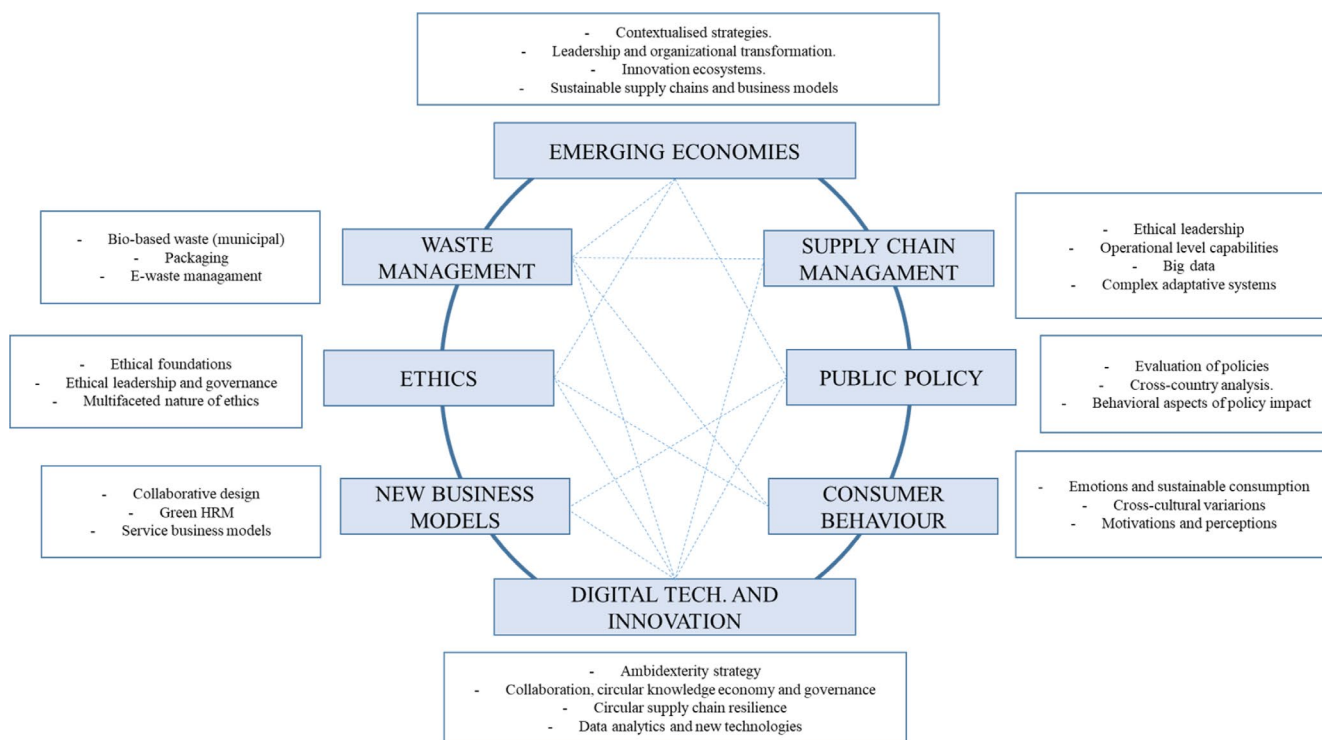


FIGURE 8 | Future research avenues for CE.

et al. 2023; Ul-Durar et al. 2023). Cross-country comparisons can elucidate best practices and the influence of cultural factors on policy outcomes (Boffa et al. 2023). This could inform global cooperation and knowledge transfer. Additionally, the behavioral impact of policies—how individuals and organizations respond to incentives or regulations—requires closer examination (Henry et al. 2021; Marrucci et al. 2022; Vallet-Bellmunt et al. 2023).

5.1.4 | Consumer Behaviour

Consumers play an indispensable role in shaping the success of CE initiatives. Research into their emotional, cultural, and motivational drivers is essential. Positive emotional states such as enjoyment, gratitude, and a sense of purpose can enhance engagement with circular practices (Chen and Dagestani 2023). Understanding these psychological dimensions can refine behavioural interventions. Cross-cultural studies are necessary to understand regional consumer preference differences and CE initiatives' responsiveness (Shashi et al. 2023). These variations can guide the localisation of CE strategies. Additionally, motivations behind sustainable production and consumption, particularly among “makers” engaged in repurposing, warrant deeper exploration (Alyahya et al. 2023; Lu and Kwan 2023).

5.1.5 | Digital Technologies and Innovation

Technologies such as AI, blockchain, and IoT offer new avenues for innovation, transparency, and resource efficiency. The balance between exploitative and explorative innovation strategies remains a topic of interest (Arekrans et al. 2023). Research could investigate when and how firms should deploy each approach to maximize CE outcomes. Moreover, collaborative frameworks such as the circular knowledge economy need to be further conceptualized and operationalized (Alkaraan et al. 2023; Ul-Durar et al. 2023). The integration of digital tools to enhance resilience in supply chains is another emerging focus. Combining IoT and big data can improve real-time responsiveness and decision-making (Gahlaut and Dwivedi 2024). Studies should also investigate how human-machine interactions evolve in Industry 4.0 contexts and the role of blockchain in ensuring supply chain transparency (Riggs et al. 2023; Saxena et al. 2023).

5.1.6 | New Business Models

The evolution of CE necessitates rethinking traditional business models. Collaboration, digitalisation, and green human resource management (GHRM) are central to this transformation. Pedersen et al. (2023) advocate collaborative design as a mechanism to align stakeholders' values and optimise transitions. Further research could analyse continuous negotiation processes that support sustainable innovation. GHRM practices can be leveraged to facilitate business model transformation, particularly within SMEs and emerging sectors such as fintech (Marrucci et al. 2022). Additionally, the service-oriented business models in sectors like construction should be examined in

conjunction with digital advancements (Broccardo et al. 2023; Stegehuis et al. 2023). Expanding this focus to less visible industries could yield important insights.

5.1.7 | Ethics

Ethics underpin all aspects of CE—from supply chains to consumer behavior and leadership. Ethical networks and leadership models are increasingly being linked with successful circular transitions. Consumers demand transparency, while firms seek to build trust through ethical branding and governance (Asante et al. 2021; Mion et al. 2021). Leadership grounded in ethical principles enhances circular adoption by fostering organizational alignment (Agyabeng-Mensah et al. 2023; Cheffi et al. 2023). Future studies should evaluate the long-term effects of ethical leadership, the influence of branding on consumer perceptions, and the interplay between ethical values, environmental sustainability, and economic performance (Herédia-Colaço 2023).

5.1.8 | Waste Management

Recent scholarship has identified promising directions in bio-based waste valorisation, sustainable packaging, and e-waste management. Bio-based waste valorisation, especially in municipal contexts, offers opportunities to reduce waste volumes while conserving resources (Chagas et al. 2022). Yet, research must address the complexity of biorefinery operations under dynamic conditions. Packaging is another crucial component. Firms are increasingly turning to sustainable packaging practices, but there remains a lack of integrated environmental performance metrics (Cozzolino and De Giovanni 2022; León and Salesa 2024). Studies should broaden their scope to include digital innovation and adaptability to global crises. Finally, e-waste management, exemplified by recent UK-based research, reveals systemic challenges that must be addressed globally (Sundar et al. 2023). Validating models across diverse regulatory and industrial contexts is essential for developing scalable, sustainable solutions.

5.2 | Critical Reflections on the TBL in CE Research

Our bibliometric findings show that scholarly work on environmental and economic aspects of the CE has grown rapidly, leading to the development of strategies focused on resource-use efficiency, reverse logistics, and new revenue models. Policies such as the European Union Circular Economy Action Plan and the Chinese 5 year plans have catalyzed much of this research momentum, and companies like Renault, Stellantis, and BMW have introduced corporate strategies designed to reduce virgin material use and greenhouse gas emissions. Many studies focus on technological and operational innovations that extend product lifecycles, integrate closed loop processes, and improve cost savings (De Pascale et al. 2021; Hapuwatte and Jawahir 2021; Nowakowski et al. 2020). These efforts show that environmentally and economically oriented CE practices are now embedded in a global context that includes Europe, China, Japan, the United States, and other regions seeking solutions to pressing resource challenges.

Despite this progress, the social dimension of sustainability remains underrepresented (Corvellec et al. 2022; Jerome et al. 2022; Kirchherr 2022). Although topics such as stakeholder engagement, leadership, and ethics appear in co-citation analyses, there is limited discussion regarding the tangible social impacts of CE implementation. Key issues include how worker well-being, fair labor practices, and social inclusion factor into material sourcing, recycling activities, and product life extension efforts. Without carefully established social indicators, the field risks becoming an eco-efficiency strategy that reduces environmental harm and achieves economic benefits, yet fails to account for the well-being of underrepresented communities or marginalized groups. Researchers like Greene et al. (2024) and Yang et al. (2022) call attention to the difficulties of developing transparent metrics that capture human and community welfare, a shortfall that can obscure whether or not gains in resource efficiency translate to broader social equity.

Recent critical perspectives emphasize that an exclusive focus on environmental and economic results can result in a partial view of sustainability. Companies can enhance production processes to minimize waste, but a lack of accountability for labor conditions or community resilience may perpetuate existing inequalities (Bocken et al. 2016; Hahn et al. 2015). Scholars are also beginning to question how widely these practices are being adopted and whether there is an overestimation of their transformative potential (Corvellec et al. 2022). For instance, some corporations may highlight their recycling initiatives while making minimal changes to core models that perpetuate unsustainable consumption patterns. Others may position CE approaches as leadership-driven branding tools without integrating clear social objectives for employees or local communities. These gaps point to the need for more critical, data-driven examinations that can determine whether CE practices are socially beneficial or merely symbolic.

Possible ways forward include the development of standardized indicators for social wellbeing in order to complement resource and economic measurements. Researchers could draw from fields such as sociology, human rights, or development studies to broaden current CE investigations beyond their prevailing technological focus. Collaborative research designs that involve industry representatives, local communities, and government agencies could help identify and measure social outcomes more systematically, thereby clarifying whether CE applications are improving the livelihoods of those most affected by shifts in production and consumption. Empirical case studies in emerging economies and rural regions could capture how cultural factors and infrastructure constraints influence the success of CE interventions, thus providing policy guidance for contexts that differ greatly from those in highly industrialized nations.

Ultimately, our findings suggest that although the CE has demonstrated considerable promise and momentum, it is not yet a complete embodiment of the TBL. The environmental and economic pillars have seen substantial advancement, but the social component remains significantly underexamined. This underrepresentation calls for closer academic scrutiny, government support, and cross-sector collaborations so that issues of equity, worker welfare, and community prosperity do not become secondary considerations. If researchers and practitioners address

these gaps through the creation of robust social metrics and inclusive governance mechanisms, the CE may mature into a genuinely sustainable model. However, until the social dimension is consistently integrated and measured, the CE will remain only partially aligned with the ideals of balanced, TBL sustainability.

6 | Conclusions

The linear production model is experiencing a generalized crisis due to the depletion of resources and the difficulty of sustaining a model based on consumerism and the disposal of products after their use. Indeed, currently, the CE model is being supported by different countries, institutions, and companies to try to solve the main limitations of the traditional model. The present study aims to identify the current state of development of CE according to the sustainability paradigm and to verify how the current literature is addressing this issue. To this end, the present study explores the evolution and patterns of a total of 815 articles covering a period of 20 years.

The results show an exponentially growing attention as well as a clear evolution of the CE state of the art, going from a theoretical development of the requirements for implementing CE as an operational engine of companies to a systemic and conscious perspective of the model. However, subsequent research has identified certain flaws in the circular model, both in terms of its environmental impact and, especially, its social impact. In the last stage analyzed, the concern about the sustainability of the model increases, and this can be seen in the incidence of some of the articles that deal with the foundations of the CE and the lack of measurement systems for circularity since even today there are no effective measurement systems or KPIs that allow the environmental impact to be accurately measured.

However, the most lagging aspect is the social aspect, which completely disappears from the main research topics. Therefore, based on the current state of science and research in the CE, it is not possible to affirm that there is unequivocal evidence that the CE complies with the definition of a fully sustainable model, with special emphasis on the TBL perspective, since the aspects related to the environment and the economic risks for the business and its efficiency in the production and management of materials are being measured with special interest, while the rest of the aspects are not being studied, since the study of the social impact of the CE is still very low today, with studies that support the lack of connection between the two aspects.

In relation to the results of this study, it is necessary to mention a series of limitations related to the sample and the methodology used. First, the dataset was collected through the WoS to obtain higher-quality results. However, this choice limited the number of publications. In addition, some exclusion criteria were imposed to improve the performance analysis, which also limited the final sample. Moreover, some indicators can lead to inconsistencies when used to compare different publications or authors. Hence, each indicator should be read together with the other ones, such as the h-index. In addition, future research could investigate deeper into the methodological techniques employed traditionally in the field, especially interesting for the exploration of technical trends and its implications within the CE literature.

Finally, while this study has primarily understood the structural and intellectual landscape of CE research, further studies could incorporate a TBL-specific classification. Future research could build on our findings by conducting content-based analyses that explicitly assess the extent to which CE research aligns with social, environmental, and economic sustainability dimensions. Each of these limitations thereby provides opportunities for future work for academics, researchers, and practitioners.

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Endnotes

- ¹ More information: <https://www.apple.com/environment/>.
- ² More information: https://ppp.worldbank.org/public-private-partnership/sites/ppp.worldbank.org/files/documents/China_CircularEconomyLawEnglish.pdf.
- ³ More information: <https://www.undp.org/sites/g/files/zskgke326/files/2022-06/Circular%20Economy%20Strategy%20and%20Action%20Plan%202021%20%28%29.pdf>.
- ⁴ More information: https://environment.ec.europa.eu/strategy/circular-economy-action-plan_en.
- ⁵ More information: https://environment.ec.europa.eu/topics/waste-and-recycling/waste-framework-directive_en.
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Appendix A

Acronym	Meaning
CE	Circular economy
CSR	Corporate social responsibility
TP	Total publications
IF	Impact factor
TBL	Triple bottom line
TC	Total citations
TLS	Total link strength
WoS	Web of science