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Integrating blockchain into the circular economy: A bibliometric and systematic literature review

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Abstract---The integration of blockchain (BC) technology into the circular economy (CE) is fast growing, but comprehending the long-term and real implications of such integration needs more extensive research. To address this research gap, we offered an integrated technique that combines bibliometric analysis with systematic literature review (SLR). The bibliometric analysis provided a complete perspective of the issue, demonstrating India's global leadership in this domain. It also identified the most important educational institutions, scientific publications, keywords, and notable researchers in this discipline. The SLR comprised a thorough review of 20 well-chosen scholarly literature. It focused on the contemporary uses of BC in the circular economy. We've identified three primary areas for BC applications: manufacturing, waste management, and supply chains. Despite their great potential, they face a variety of constraints, which may be divided into four categories: administrative challenges, technological and financial impediments, social challenges, privacy concerns, and security issues. The study finds that successful integration of BC into the CE necessitates more research, notably on the technological and economic viability of the integration.

Keywords---blockchain, circular economy, bibliometric analysis, Systematic Literature Review (SLR), Scopus.

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1. Introduction

In a linear economy, raw materials are utilized in production, after which the completed products are distributed to consumers and ultimately discarded as waste [1]. This approach results in impractical extraction and disposal methods. The Intergovernmental Panel on Climate Change reports and the Sixth Global Environmental Outlook of the United Nations indicate that we are experiencing a climate emergency, with significant pressure on our planetary boundaries.

The circular economy (CE) concept advocates for a transition from a linear to a circular production system, aiming to minimize mineral extraction, pollution, and waste while fostering a sustainable economy [4]. The circular economy is defined as "an economic model wherein planning, resourcing, procurement, production and reprocessing are designed and managed, as both process and output, to maximize ecosystem functioning and human well-being" [5].

Innovation is regarded as a valuable instrument for advancing the circular economy, particularly in the context of gathering data on the life cycles of products, encompassing manufacturing, delivery to consumers, and waste management. Here, but not limited to, Blockchain (BC) technology represents a significant and innovative approach to the exchange and updating of information [7]. Blockchain serves as an illustration of an open, distributed ledger that facilitates peer-to-peer network data sharing. It digitizes global supply chains, ensuring traceability, data security and stability, while eliminating the need for mediation [9]. This promotes responsible procurement and guarantees the efficient reuse and recycling of materials.

The ambiguity of the research topic regarding its primary orientations, priorities, and challenges restricts the capacity of researchers and practitioners to comprehend the application of blockchain technology in enhancing resource management within the circular economy. This paper aims to present a thorough and impartial review of the impact of BC on the CE. This study synthesizes numerous scientific articles, academic contributions, and research studies to ascertain the present and future trajectory of this topic, aiming to guide researchers and decision-makers in the application of BC technology for a swift transition to a CE. This study is significant due to its novel topic and comprehensive approach, integrating bibliometric analysis with a systematic literature review (SLR) [12]. This perspective positions the paper as a significant and necessary contribution to the field of environmental economics technology research.

This review will be divided into two main parts: In the first part on bibliometric analysis, we will be able to answer the following question:

1) What is the evolution of published research on the integration of BC into CE in the most prominent academic institutions and scientific journals?

As for the second part related to the SLR, we will answer the following questions:

2) What are the various applications of BC in CE?
3) What are the results achieved by integrating BC into the CE?
4) What are the challenges related to the impact of BC technology on the CE?
5) What are the future directions for integrating BC technology into the CE?

2. Materials and Methods

2.1 Research Design

This study aims to examine the integration of BC technology with CE through bibliometric analysis and a systematic literature review (SLR). Employing the PRIMA framework [13]. This comprehensive approach was chosen to provide a more thorough and integrated understanding of the concepts related to this rapidly evolving field.

2.2 Research Strategy

On August 11, 2024, a comprehensive analysis of scientific publications regarding the integration of blockchain into the circular economy was conducted using the Scopus database, employing two keywords: blockchain and circular economy. For example, TITLE-ABS-KEY ("Blockchain" AND "Circular Economy"). Initial research into the bibliometric study identified 374 research projects. The results were subsequently modified and refined based on specific research criteria that were not aligned with the objectives of our study. Refer to the criteria outlined in Table 1.

Table. 1
Inclusion And Exclusion Criteria

Inclusion	keywords+ any related keywords ("blockchain " AND "circular economy")
Exclusion	Conference paper, Book chapter, Book Languages other than English

This study examines articles published from 2018 to 2023, focusing on the analysis of research within this timeframe. For example, PUBYEAR > 2017 AND PUBYEAR < 2024. The documents utilized were exclusively articles, excluding conferences, books, and other papers lacking substantial scientific credibility. For example, LIMIT-TO (DOCTYPE, "ar"). To facilitate the analysis process for authors, only research written in English was included, while other languages were excluded. For example, LIMIT-TO (LANGUAGE, "English"). To ascertain the relative significance of these publications, we performed a manual review, briefly examining the titles and abstracts.

2.3. Quality Assessment

This article outlines the implementation of quality standards across three stages. In the initial phase, preliminary research was conducted utilizing the Scopus database, resulting in 374 searches as previously indicated. The second phase entailed narrowing the article count to 145 by applying the criteria outlined in Table 1. The third phase was conducted manually by researchers and certain reviewers, resulting in the successful download of only 48 out of 145 articles. This is attributable to various factors, including the presence of articles that necessitate a subscription for access, Scopus' limitations on downloading, and other unidentified elements affecting researchers.

The remaining 48 articles were re-evaluated by researchers, who meticulously analyzed titles, keywords, and abstracts. Thirteen articles were excluded due to incompatibility with the research subject, and three others were dismissed based on language criteria. Furthermore, the articles underwent a manual quality assessment to eliminate theoretical studies, leading to the exclusion of an additional 12 articles. Consequently, the total count of remaining articles was limited to 20. Figure 1 illustrates the application of the PRISMA framework to elucidate the methodology of this review.

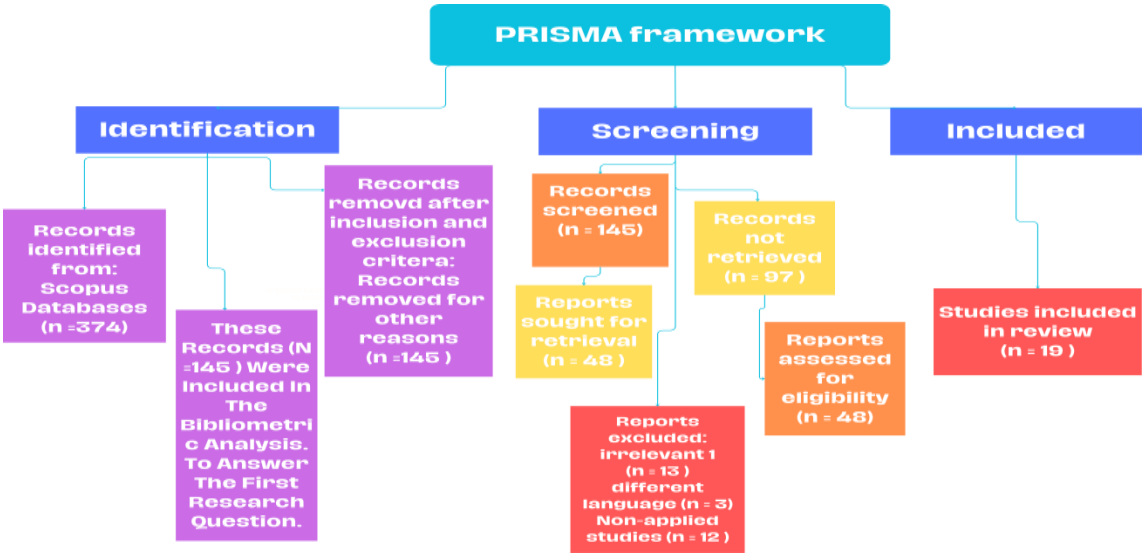

Fig. 1. PRISMA framework.

3. Results

The identification of trends and patterns was conducted through bibliometric analysis, offering a contextual framework for deriving precise insights from the systematic literature review [14]. Bibliometric analysis identifies significant developments and topics within the field, whereas a systematic literature review offers an in-depth examination of selected studies addressing these issues.

3.1 Bibliometric analysis

3.1.1 Distribution of articles on BC and CE

The number of articles addressing the topic of BC and CE during the study period from 2018 to 2023 significantly rose post-2021, with 31 articles published compared to only 5 in 2019. In 2023, the peak reached 57 articles (as illustrated in Figure 2). This demonstrates a significant interest in the application of BC techniques within circular economics. A substantial increase in the number is anticipated in the forthcoming years.

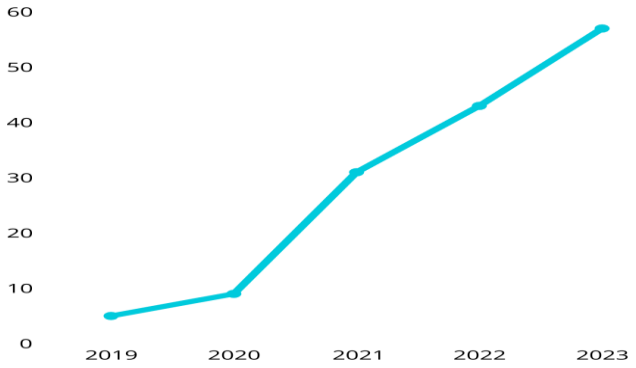

Fig. 2. Distribution of scientific publications during the years 2019-2023

3.1.2 Leading countries in integrating BC technology with CE

The bibliometric analysis indicates that India, the UK, and China significantly influence the intellectual landscape, as demonstrated by their respective publication counts of 26, 25, and 20 during the study period. The superiority of these states can be attributed to several factors. The Indian authorities have initiated several programs aimed at national development, including the VIKSIT BHARAT @ 2047 initiative [15]. This initiative emphasizes technological development and environmental sustainability as essential components. The UK and China prioritize research and development in advanced technology, alongside government policies that promote innovation in BC and CE. Turkey, despite being an emerging nation, holds the tenth position in global rankings. The adoption of a comprehensive approach to achieving sustainable development goals is integrated into national development plans. This facilitated the swift advancement and evolution of the intellectual environment in that context. The remaining top ten countries are illustrated in Figure 3.

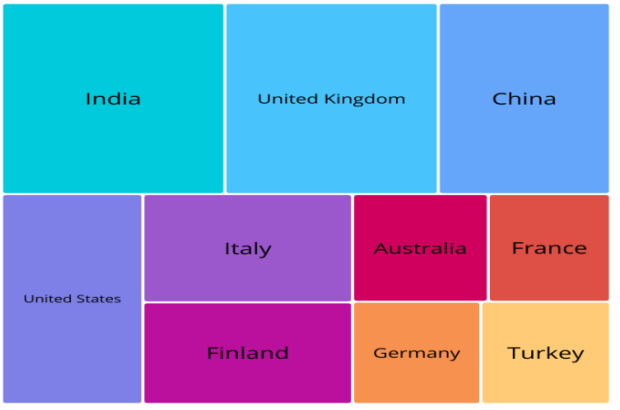

Fig. 3. Leading countries in integrating BC technology with CE

3.1.3 The most important research institutions in the field of BC and CE

Worcester Polytechnic Institute in the USA is a leading institution in publishing within our research area, holding the largest share with approximately 8 publications. Following closely is "Hanken - Svenska handelshögskolan" in Finland, ranked second with 5 publications. The Indian Institute of Technology Bombay ranks 10th, contributing 3 publications. The emphasis on the institutions referenced arises from their advanced academic programs in technology and economics, which enhances their capacity for conducting in-depth research on the topic. Figure 4 illustrates additional institutions.

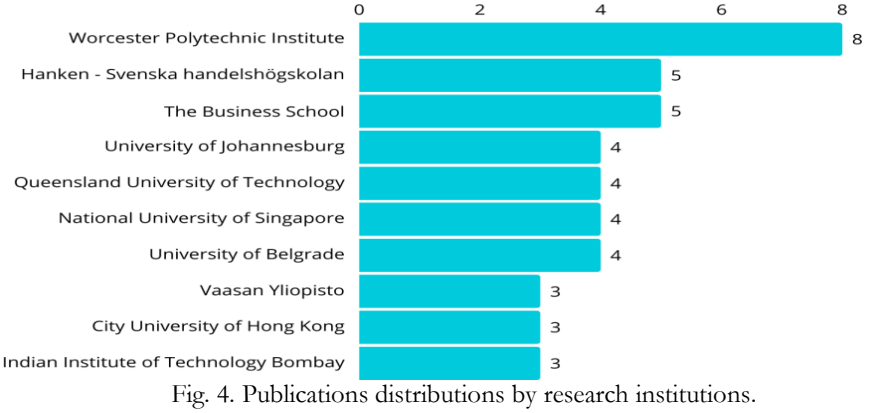

Fig. 4. Publications distributions by research institutions.

3.1.4 The top authors in the field of BC and CE

Table 2 presents the foremost researchers in BC integration within the CE, identifying a total of 10 individuals, among whom Sarkis Joseph is notably distinguished. His research output comprises 528 scientific papers, an H-Index of 116, and a cumulative total of 55,401 citations. Affiliated with Worcester Polytechnic Institute in the UK, other researchers in the table below delineate the global research landscape on the subject.

Table. 2
The top authors in the field of BC and CE

Author	[1]TP	H-Index	[2]TC	AFFILIATION	COUNTRY
Sarkis, Joseph	528	116	55,401	Worcester Polytechnic Institute	United States
Ramakrishna, Seeram A	2,104	172	143,61	National University of Singapore	Singapore
Ajwani-Ramchandani, Raji	7	4	165	Info Indian Institute of Technology Bombay Mumbai	India
Kouhizadeh, Mahtab	20	12	4,121	College of Business The institution will open in a new tab, Kingston	United States
Zhu, Qingyun Serena	39	18	1,979	Fowler College of Business The institution will open in a new tab, San Diego	United States
Agrawal, Rajeev	75	16	1,064	Malaviya National Institute of Technology Jaipur The institution will open in a new tab, Jaipur	India
Baumgartner, Rupert J	96	38	5,659	Info Universität Graz The institution will open in a new tab, Graz	Austria
Bjelobaba, Goran	2	2	15	Info University of Belgrade The institution will open in a new tab, Belgrade	Serbia
Bucea-Manea-Ţoniş, Rocsana	28	10	349	National University of	Bucharest

				Physical Education and Sports	
Chopra, Shauhrat S.	84	32	2,805	Info City University of Hong KongThe institution will open in a new tab,	Hong Kong

1 = Total Publications, 2 = Total citations

Numerous magazines have published articles on this topic, indicating its significant academic relevance in recent years. We conducted a content analysis of 374 articles from our research, selecting criteria for evaluation that included "Journal," "Number of articles published," "Total citations," "Impact factor," "Title of the most cited published article," "Number of citations," and "Publisher," as detailed in Table 3.

Five prominent journals have been identified that concentrate on the integration of BC into the CE. The journal "Sustainability (Switzerland)" published by MDPI comprises 55,991 publications and has received 381,357 citations, resulting in a citation score of 6.8. The most cited article is titled "Chatbots in Education and Research: A Critical Examination of Ethical Implications," which has garnered 148 citations. The second order includes the Journal of "Cleaner Production" published by Elsevier, which has a total of 19,382 publications and 381,357 citations, resulting in a citation score of 20.4. The article titled "Green Technical Innovation, Green Finance, and Financial Development and Their Role in Green Total Factor Production: Empirical Insights from China" has received 279 citations. Alongside other cited works, these papers lead in academic publishing within the BC and CE, advancing the field through a range of diverse research avenues.

The predominant subjects in these journals pertain to technology, innovation, sustainable development, and digital transformation. This trend underscores the increasing global interest in applying modern technologies to meet environmental and developmental objectives, as well as the challenges linked to their implementation.

Table. 3
The top journals that focus on of BC and CE

Journal	Tp 2023	Tc 2023	Cite score (2020-2023)	Most cited article	Time cited	Publisher
Sustainability (Switzerland)	55991	381357	6.8	Chatbots in Education and Research: A Critical Examination of Ethical Implications and Solutions	148	MDPI
Journal of Cleaner Production	19382	394597	20.4	Green technological innovation, green finance, and financial development and their role in green total factor productivity: Empirical insights from China	279	Elsevier
Business Strategy and the Environment	1065	23959	22.5	Digitalization and sustainable development: How could digital economy development improve green innovation in China?	274	John Wiley & Sons
Computers and	2976	37804	12.7	Leveraging digital capabilities	65	Elsevier

Industrial Engineering				toward a CE: Reinforcing sustainable supply chain management with Industry 4.0 technologies		
Resources, Conservation and Recycling	2166	49661	22.9	Conceptualizing the CE (Revisited): An Analysis of 221 Definitions	169	Elsevier

3.1.5 The top keywords used in publication in the field of CE and BC

VOS Viewer is a software commonly utilized for the analysis of bibliographic networks, facilitating the detection of network perceptions (Abuhassna et al., 2022, p. 83). The chart below illustrates the most prevalent and interconnected keywords related to the integration of BC technology with CE. The word 'CE' appeared 105 times more frequently, and the total link strength was 392, indicating the significance of this topic in the research. The term 'BC' was subsequently reiterated in as many as 85 instances, with the overall link strength quantified at 349, signifying it as another significant topic. Terms like "sustainable development," "supply chain management," and "industry 4.0" frequently emerge in communication, indicating their significant and coherent interrelations in connecting BC and CE within published research.

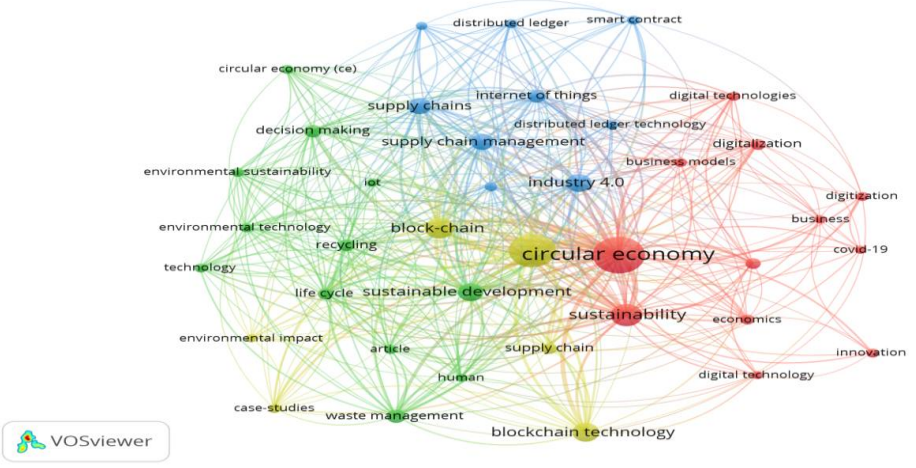

Fig. 5 The most often used terms in BC /CE publications

3.2 SLR

3.2.1 Various practical applications of BC in CE

Following a review and analysis of 20 scientific papers, we present an overview of the ways in which the circular economy is redefined through blockchain technology, along with the diverse practical applications of this technique.

[17] examined the role of BC in enhancing inter-firm cooperation and optimizing resource utilization to minimize waste. The review [18] demonstrates the application of BC in enhancing manufacturing processes. [19] discussed the application of techniques like BC for evaluating and enhancing sustainability in manufacturing. [20] elucidated the ways in which BC connectivity with IoT can enhance resource management and industrial processes.

Study [21] identifies the obstacles associated with the adoption of blockchain technology in the circular economy. [22-25] examined the role of blockchain in enhancing plastic waste management, promoting

sustainable recycling practices, and elucidating the application of blockchain, artificial intelligence, and smart contracts in optimizing waste segregation.

This study examines the role of BC in enhancing the environmental supply chain within the coffee industry. This review examines how BC companies gain advantages through transparency and efficiency. [28] proposed digital solutions based on blockchain technology to facilitate the implementation of a circular economy, grounded in a comprehensive understanding of existing challenges.

[29] examined the applications of blockchain in enhancing food supply chains. Addressed the management of electronic devices and waste through the application of blockchain and the Internet of Things. Focus on innovation and investment in technology, including blockchain, in Europe. Finally, [32] observed the role of BC in enhancing the product elimination process within the CE.

These papers offer a thorough analysis of the substantial influence that the BC future will exert on expediting the transition to a CE.

3.2.2 Results of BC integration into CE

Among the most notable findings of the 20 research papers shown in the table are:

Table. 4
Findings obtained through articles

Studies	Findings
[17]	Using BC-based smart contracts to support industrial information systems and proposing an engineering framework for engineering these contracts to facilitate industrial symbiosis.
[33]	BC technology has shown positive impact on green design, green manufacturing, recycling and manufacturing in Pakistan.
[18]	28 challenges and 22 actions were identified for industry applications 4.0 and CE in manufacturing, with a practical framework proposed to improve energy, waste and quality management using BC.
[34]	New technologies support Brazil's I4.0 industry and circular economy in the food sector.
[19]	After evaluating several manufacturers it was found that one manufacturer was best based on sustainability criteria such as resource efficiency, waste reduction, and the ability to adopt modern technologies such as BCand others to support the circular economy.
[31]	Innovation and investment in CE significantly influence the number of patents. The adoption of digital technologies like BC is crucial for sustainable societal transformation.
[35]	Barriers are classified according to TOPSIS method, with strategies based on BC technology and IoT proposed to mitigate these barriers.
[26]	Applying BC in the coffee supply chain needs to be expanded to include reusable waste to enhance the CE.
[27]	The closed supply chain system relies on incentives for aggregators to boost the CE, but consumer incentives may negatively affect the BC.
[28]	Smart contracts and BC can solve CE problems, and enhance confidence and transparency in supply chains.
[29]	BC technology supports transparency in supply chains but is still in its initial stages in India.
[21]	The main barriers to BC adoption in the CE are lack of knowledge and administrative support, while investment and safety costs are the least important ones.
[24]	BC use in waste management includes cryptocurrency payment, recycling rewards, and waste tracking, with benefits in reducing costs.
[30]	A combination of IoT and BC helps monitor products and improve decisions associated

	with the CE.
[20]	The BC system proposal records changes to assets using smart contracts to distribute complex tasks among the system's participants.
[36]	Three circular business models based on BC in the fashion industry contribute to the transition towards a CE.
[23]	BC contributes to the effective separation and collection of plastic waste using codes to enhance plastic waste management.
[22]	Sensor and artificial intelligence techniques facilitate the separation of plastic waste, and propose a BC platform to share information about the suitability and quality of recycled plastic.
[25]	BC helps solve sustainable waste management challenges across 3 axes: determining product ownership, supporting legal and political objectives, and protecting sensitive information.
[32]	The BC deletion technique helps reduce the risks related to inventory, waste and information within the CE.

Results show that BC technology plays a significant role in supporting the shift towards a CE. BC can also help overcome many of the challenges facing Industry 4.0 and the applications of CE.

3.2.3 Challenges of applying BC in the CE

The studies indicate that the integration of BC technology into the CE encounters several challenges, particularly the absence of trust among institutions and the complexities associated with adopting modern technologies. The challenges associated with implementing blockchain in sustainable manufacturing can be categorized into five primary groups: management, signature, encryption, algorithms, decentralization, smart contracts, regulations, and standards. However, the challenges related to management are of greater significance [18]. Furthermore, the integration of BC into the CE encounters considerable obstacles stemming from the enforcement of complex environmental regulations and insufficient governmental backing [35]. Challenges are often categorized into five primary types: technological, financial, structural, institutional, and social [28]. Additional challenges encompass elevated costs, insufficient infrastructure, ambiguous regulatory frameworks, and privacy concerns [29]. Blockchain technology remains in its early development phase, encountering challenges such as elevated investment costs, security vulnerabilities, and obstacles to commercial growth [37].

In the food sector, issues arise from trust deficits and fraudulent data, alongside technical challenges associated with blockchain application, including the absence of practical implementations for this technique [26]. Consumer incentives can adversely impact the BC system, complicating the adoption of sustainable practices [27]. Consumer acceptance and the adoption of radical innovations represent significant obstacles to the application of BC, alongside barriers inherent to each economic sector [36]. The limited awareness of this technology in certain sectors, including recycling, combined with technological complexities and substantial initial investment costs, hinders its widespread adoption.

3.2.4 Future prospects for BC in the CE

The findings suggest significant potential for broadening the application of BC in the CE to promote sustainability. A primary trend is the incorporation of blockchain technology into industrial symbiosis and circular business models, necessitating research on the technological, economic, cultural, and organizational feasibility of these applications across various global contexts [17]. The shift towards a circular economy predominantly reliant on biocircularity requires additional research to formulate economic models centered on this technology [28]. This integration may be facilitated by manufacturing systems within companies, with governments potentially supporting this process through tax exemptions and soft loans for those that implement blockchain technology in their operations[33].

The application of BC should be broadened to encompass the management of by-products and waste across supply chains [26]. To enhance the effectiveness of BC applications in the future, it is essential to

broaden protection mechanisms and develop self-improving AI systems that enhance data security and integrity [20]. The partnership between companies and waste collectors can be enhanced through BC-based reward systems that facilitate effective data exchange across various supply chains [23]. To accomplish this, BC may be evaluated with a cohort of companies to analyze its performance under real-world conditions [22].

Potential for the application of blockchain technology in the circular economy to improve sustainability, emphasizing its integration into industrial frameworks and the necessity of governmental support. The text highlights the significance of waste and by-product management, the establishment of data protection mechanisms, and the enhancement of collaborations between companies and waste collectors via blockchain-based reward systems.

4. Discussion

4.1 bibliometric analysis

The number of articles on BC supporting the CE has significantly increased since 2021, reaching a peak in 2023. This indicates an increasing global interest in the topic. India, the United Kingdom, and China emerged as prominent nations in this domain, attributable to various factors. National initiatives that emphasize technological development and environmental sustainability, advancements in research and development, and supportive government policies significantly influence the trajectory of technological innovations, particularly in the domains of BC and CE.

Worcester Polytechnic Institute in the United States is a leading academic institution in publishing research related to BC and CE, distinguished by its advanced programs in technology and economics. Sarkis Joseph is a notable academic who has made substantial contributions to publishing through his association with the same institute. Sustainability refers to the capacity to maintain ecological balance and resource availability for future generations. It encompasses practices that promote environmental health, economic viability, and social equity. Switzerland leads in academic journals dedicated to publishing research on BC and CE, offering a significant platform for researchers to showcase recent advancements in this area.

Furthermore, terms like "sustainable development," "supply chain management," and "Industry 4.0" are crucial in connecting technology and the circular economy in this research, enhancing the overall influence of contemporary technologies on the sustainability of economic processes.

4.2 systematic literature review (SLR)

The review by [38] on the integration of blockchain technology in the circular economy identified five primary research themes: the relationship between blockchain and Industry 4.0, the potential of blockchain to support circular economy practices, its role in energy and waste management, and its impact on sustainability. The review by [7] examined blockchain's capacity to assist companies and industries in overcoming challenges, emphasizing its application in mitigating various environmental issues across different phases of the building life cycle, from material production to demolition [39]. The study by [40] examined the potential of blockchain and other digital technologies to offer flexible solutions throughout the product life cycle.

This study diverges from prior research by identifying distinct perspectives and examining the topic from multiple angles. This review summarizes the applications of BC technology within the circular economy, focusing on three primary areas: manufacturing, waste management, and supply chains. In manufacturing, blockchain significantly facilitates collaboration among companies by enabling secure and transparent data exchange regarding materials and production processes, thereby promoting optimal resource utilization and waste reduction.

In waste management, BC technology facilitates the tracking of material life cycles, encompassing manufacturing stages through to recycling. Blockchain-related smart contracts significantly automate processes like waste separation and recycling, thereby reducing costs and enhancing overall waste management efficiency, while minimizing the necessity for human intervention. In supply chains, blockchain technology can monitor products throughout all phases of production and distribution, thereby improving transparency and ensuring adherence to environmental standards. Moreover, monitoring raw materials and components throughout the production cycle in manufacturing improves the efficiency of supply chain management.

The implementation of BC technology in CE encounters several intricate challenges, which can be categorized into four primary groups:

- Administrative, organizational, and technological challenges. The absence of trust among enterprises constitutes a critical issue, as organizations require substantial confidence in the employed technology to facilitate the secure exchange of sensitive data. The complexity of BC systems hinders understanding and adoption by many institutions, thereby delaying the accreditation process.
- Challenges related to technical and financial aspects. Insufficient technological infrastructure posed a challenge, as the establishment of BC networks necessitated substantial investment. The innovative nature of this technology indicates that numerous solutions remain in pilot phases, leading to hesitance among companies to allocate substantial resources to technologies that have not yet demonstrated full efficacy.
- Social challenges. Unexamined incentives can result in unsustainable behaviors that may adversely impact the effectiveness of technology. The acceptance of this new technology by the public presents a significant challenge, particularly given consumers' inherent resistance to change.
- Challenges related to privacy and security. Despite ongoing advancements in blockchain technology, it continues to be susceptible to threats related to cyberhacking.

5. Conclusions

Awareness of the urgent necessity for a transition to a circular economy is becoming increasingly significant, as rapid technological advancements are pivotal in this transformation [41]. BC technology is recognized as a promising technology. This study presents an overview of research published between 2018 and 2023, analyzing findings on BC applications in circular economics. The study employed two primary methodologies, utilizing bibliometric analysis to identify a significant expansion of the conceptual framework related to the research topic. A systematic literature review indicates significant potential for the broader application of this technology in supporting the circular economy. Significant trends encompass industrial symbiosis and circular business models. There is an increasing focus on the integration of blockchain technology into circular business models, which promotes collaboration among companies and improves the efficiency of resource and process management. This integration necessitates comprehensive research into the technological, economic, and regulatory dimensions of blockchain applications across various contexts.

- Governments play a crucial role in promoting the adoption of blockchain technology by offering incentives, including tax breaks and soft loans, to companies that implement this technology. Public policies can facilitate an environment conducive to innovation.
- Broadening the application of BC Use, The application is anticipated to broaden to encompass the management of by-products and waste throughout supply chains. Furthermore, conducting practical experiments in collaboration with various companies is essential to assess the effectiveness of BC under real-world conditions.
- Developing advanced data protection mechanisms to ensure the future success of BC applications.

In conclusion, adopting these trends and implementing practical proposals will ensure the responsible and effective use of blockchain technologies to facilitate the rapid transition towards a circular economy.

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Authors' contributions
The primary author contributed to the study's preparation and planning, as well as composing and drafting the final text of the paper. The second author carried out a thorough assessment and analysis of the articles under consideration, as well as supervising the selection of relevant articles and data analysis for the bibliometric research and systematic literature review. The remaining authors provided overall supervision of the work, including quality assurance and coordination of activities among authors to ensure that the study met academic standards.

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Conflict of interest
The authors state that there are no conflicts of interest associated with this work.

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