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A Comprehensive Bibliometric Review of Circular Economy in the Building Sector: Integrating Sustainable Practices

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1. Abstract

This study conducts a bibliometric literature review to analyze the sustainable performance of circular economy practices in the building sector, aiming to identify key research trends, influential publications, and collaborative networks. A systematic search was performed on the Scopus database, yielding 779 relevant articles. We used VOSviewer to conduct a bibliometric analysis focusing on co-authorship networks, citation patterns, keyword co-occurrence, co-citation, and bibliographic coupling. These analyses provided a detailed visualization of the research landscape. The analysis revealed significant clusters of research activity, highlighting key authors, influential journals, and widely cited works. The study identified prevalent themes and concepts, illustrating the development of circular economy practices in the building sector. Network visualizations showed strong collaborations and citation linkages among leading researchers and institutions. This bibliometric review offers a comprehensive overview of research trends in circular economy practices within the building sector. Uncovering patterns and key contributions provides valuable insights for researchers and practitioners focused on sustainability and resource efficiency in the built environment.

2. Introduction

The building sector is a significant contributor to global environmental issues, such as climate change and global warming, buildings consume approximately 40% of global energy consumption [1], 33% of greenhouse gas emissions [2], and 50% of energy used for raw material extraction [3]. These factors adversely affect biodiversity and the environment, leading to climate change and global warming, which then impact human health [4].

The circular economy (CE) concept, promoted by the European Union (EU) and other organizations [5], refers to consumption and production that involves reusing, recycling, and renewing materials for the longest possible period [6]. This approach minimizes waste produced when materials approach the end of their useful life, improving the economy by lowering the demand for and expense of non-renewable resources and reducing the likelihood of repeatedly using them [7]. The circular economy uses "closing the material loop," allowing materials to be recycled, reused, and remanufactured instead of using traditional principles [8]. This approach addresses factors and challenges that affect people, planet, and profit. It also incorporates benefits

such as reducing costs, creating a diversified work environment, and promoting life [9]. The implementation of circular economy strategies can play a significant role in elevating the global significance of sustainability, resolving persistent environmental issues, offering a comprehensive, holistic, and regenerative approach to economic activities, and understanding resource management, production processes, and waste management [10].
The use of circular economy practices in the building sector has implications for economic, environmental, and social aspects that have not been fully explored in the literature.

The main aim of this bibliometric review paper is to comprehensively analyze and synthesize existing research on circular economy (CE) practices within the building sector by combining the three aspects of environmental, economic, and social. This dual focus on trend identification and impact assessment provides valuable insights into how (CE) strategies can address environmental issues and foster a more sustainable and regenerative approach to building practices. The specific objectives include identifying influential authors, key themes, and research gaps in the field. This bibliometric analysis will provide a clear overview of the current state of research, highlighting areas of consensus as well as opportunities for further investigation.

3. Research Methods

This study employs a comprehensive bibliometric approach to systematically analyze the sustainable performance of circular economy practices in the building sector. The methodology is designed to refer to (*Fig. 1*) to extract and interpret key patterns, trends, and relationships within the existing body of literature. The approach involves several key steps, from identifying research objectives and selecting appropriate bibliographic databases to applying bibliometric analysis using specialized software. The findings from these analyses are discussed in depth to provide actionable insights and future research recommendations

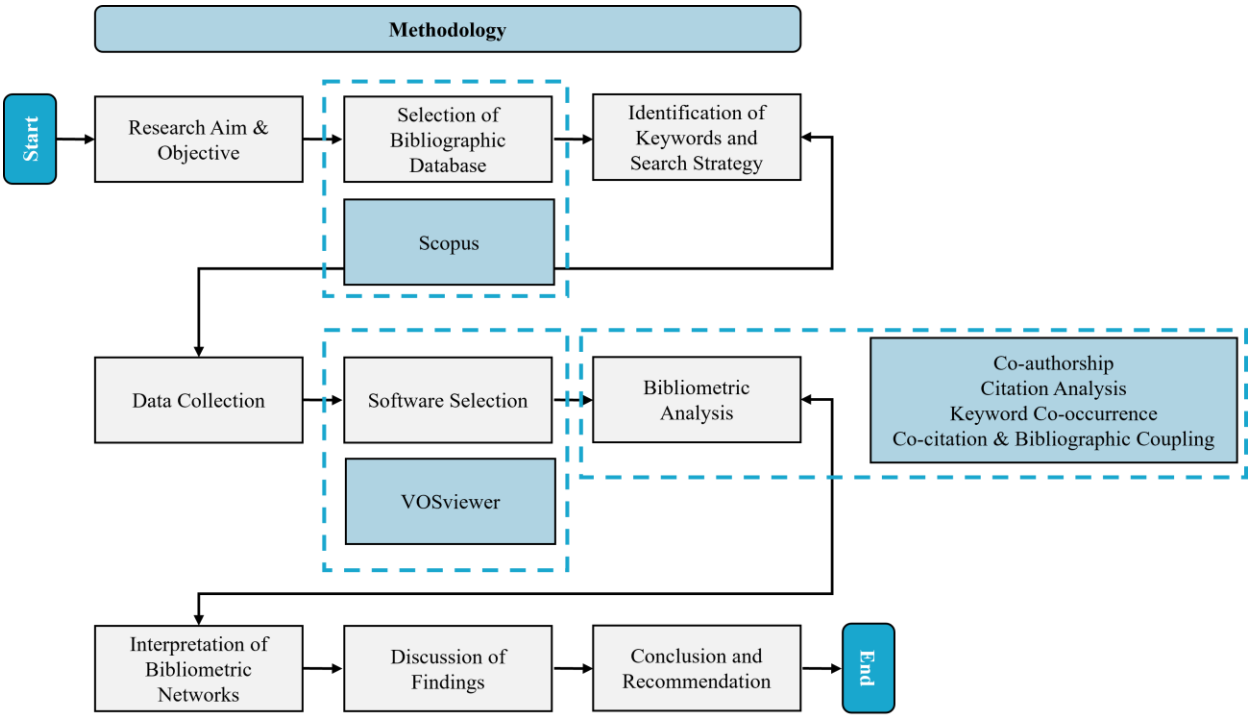

Fig. 1 Flow Chart of the Research Methodology.

3.1 Database Selection

Scopus and Web of Science are the two predominant search engines that encompass data about the circular economy [11]. Furthermore, both databases can extract bibliometric data in all formats compatible with VOSviewer; however, they vary in the quantity of resulting publications. Consequently, Scopus was selected due to its broader publication coverage and more current data that substantiate the research topic, making it superior for bibliometric data extraction in comparison to Web of Science and Google Scholar [12]. Furthermore, prior bibliometric studies on the circular economy utilized Scopus as the main database [13].

3.2 Keyword Selection and Search Strategy

The literature review aimed to explore sustainable performance in the building industry using circular economy concepts. Using the Scopus database, the search found 779 entries highlighting the growing interest in circular economy techniques and the building sector. The abundance of findings underscores the importance of this discipline and the increasing focus on resource economy and sustainability in both industrial and academic domains. This thorough search is crucial for further analysis, identifying trends and insights, and deepening knowledge of sustainable building techniques and circular economy ideas.

3.3 Software Selection

VOSviewer was selected as the primary tool for bibliometric analysis due to its robust capabilities in visualizing and mapping bibliometric networks [14]. This open-source software offers essential functionalities for analyzing co-authorship, citation, and keyword co-occurrence networks, which are vital for identifying patterns and trends in the extensive dataset used in this study [15]. Its ability to manage large datasets makes it particularly suitable for exploring research on circular economy practices in the construction industry [16]. Additionally, VOSviewer has been successfully applied in similar research areas such as sustainability, environmental science, and resource efficiency, highlighting its relevance and reliability for examining academic contributions related to the circular economy and sustainable construction practices [17].

4. Results and Discussion

The review identifies several knowledge gaps in the circular economy (CE) practices within the building sector. There is a lack of comprehensive studies on the social impacts of (CE), such as community well-being and job creation. Additionally, the long-term environmental benefits, like carbon footprint reduction, are not thoroughly analyzed. Economic implications, including cost savings and market advantages, also require more exploration. Furthermore, integrating (CE) practices into existing processes and understanding the barriers to adoption need further research. Addressing these gaps will require interdisciplinary efforts to provide empirical evidence supporting the broader adoption of (CE) practices in the building sector.

4.1 Annual Publication Trend

The study of publications on the circular economy in the building industry (*Fig. 2*) a significant upward trend over the past few decades. From 1979 to 2023, there has been a gradual increase in the number of publications, with notable peaks beginning in the early 2000s. The 1980s and early 1990s saw minimal research activity, but a marked increase began around 2008, culminating in a peak of 122 scientific publications in 2023. This exponential growth reflects an increasing scholarly interest in integrating sustainable practices within the circular economy framework, particularly highlighting the growing recognition of its importance in the building industry and the expanding research aimed at enhancing sustainability in this sector.

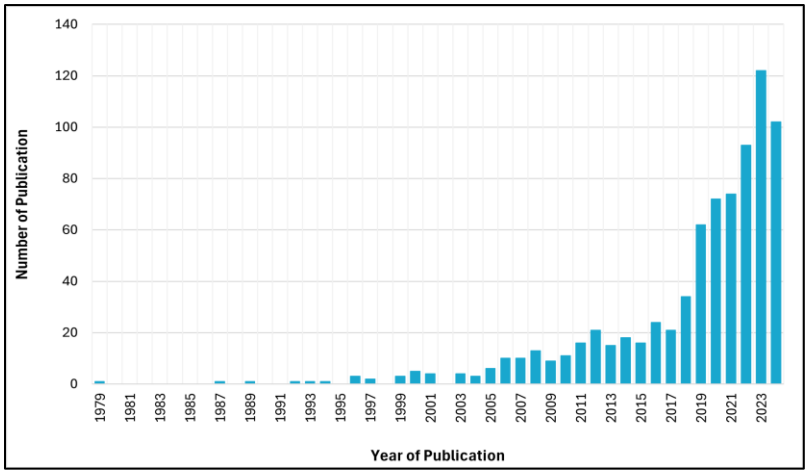

Fig. 2 Annual Distribution of The Included Studies.

4.2 Co-Authorship Network

The bibliometric study on circular economy in the building industry reveals significant disparities in research impact and citation counts among authors. In (*Fig. 3*) and (*Table 1*) shows Lu, Weisheng [18] leads with 8 articles and an average of 55 citations per article, totaling 440 citations. Yuan, Hongping [19] follows closely with 6 articles and 347 citations, averaging 58 citations per article. In contrast, Bao, Zhikang [20] has 4 articles with a lower average of 30 citations, but a notable normalized citation average of 6.41, indicating substantial influence relative to his publication volume. Hossain, Md. Uzzal [21] also stands out with 4 papers and a total of 603 citations, showcasing a high average citation count. Conversely, Ma, Xiaozhi [22], with only 2 articles, has a low impact, averaging just 3 citations each. The study also highlights varying degrees of connectivity within the research network, with Yuan, Hongping [19] and Zuo, Jian [23] exhibiting significant link strengths of 12 and 11, respectively. This analysis underscores the differing levels of influence and research network connectivity.

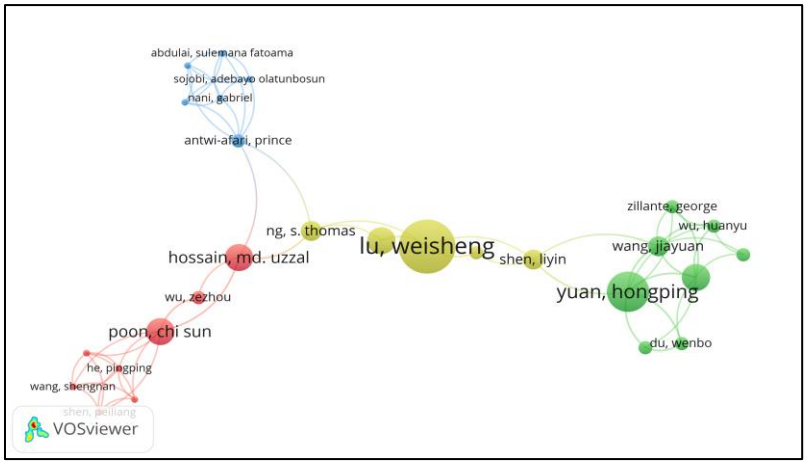

Fig. 3 Co-Authorship Network.

Table 1 Most Collaborative Researchers' Analysis.

Author	No. of articles	Citations	Av. citations	Av. norm. citations	Total link strength
Lu, Weisheng	8	440	55	3.70	7
Yuan, Hongping	6	347	58	2.99	12
Bao, Zhikang	4	118	30	6.41	4
Hossain, Md. Uzzal	4	603	151	4.12	6
Poon, Chi Sun	4	315	79	2.27	9
Zuo, Jian	4	318	80	3.43	11
Ng, S. Thomas	3	422	141	5.35	5
Shen, Liyin	3	244	81	1.91	5
Wang, Jiayuan	3	297	99	3.71	9
Antwi-Afari, Prince	2	281	141	8.22	7
Chen, Xi	2	232	116	3.45	3
Du, Wenbo	2	6	3	4.64	5
Ma, Xiaozhi	2	6	3	4.64	5
Tam, Vivian W.Y.	2	148	74	2.81	3
Wu, Huanyu	2	231	116	4.39	7
Wu, Zezhou	2	170	85	2.57	3
Zillante, George	2	189	95	2.89	5

4.3 Co-Occurrence Network of Keywords

It shows in (*Fig. 4*) and (*Table 2*) The circular economy and sustainable practices in the building sector are gaining prominence, with the term "circular economy" appearing 148 times and a total link strength of 231, indicating a growing consensus on integrating circular economy principles across various sectors. The second most frequent term, "sustainability," emphasizes the field's commitment to long-term environmental balance, but its slightly lower occurrence indicates a shift from broad sustainability concepts to more specific strategies, such as "waste management" and "life cycle assessment" (LCA), which emphasize the importance of material efficiency in managing and accessing the life cycle impacts of building materials. "Construction and demolition waste" and "adaptive reuse" focus on managing the environmental challenges of existing structures, with growing interest in prolonging the lifecycle of construction materials through processes like "reuse" and "recycling". The frequency of terms like "concrete" and "building materials" indicates a future shift toward optimizing material choices within the circular economy framework. This analysis suggests a maturing field where general discussions on sustainability and circular economy are giving way to more detailed examinations of material efficiency, waste reduction, and lifecycle impacts. Researchers are increasingly focusing on practical applications and the specific challenges of incorporating circular economy principles into the construction sector, a trend likely to shape future developments in sustainable building practices.

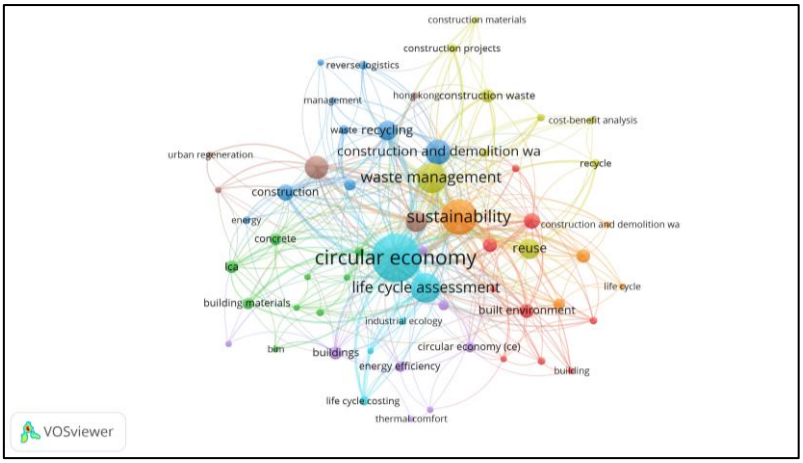

Fig. 4 Co-Occurrence Network of Authors' Keywords

Table 2 Most Active Keywords in The Research.

Keyword	Occurrences	Total link strength
Circular economy	148	231
Sustainability	87	143
Waste management	65	120
Life cycle assessment	64	109
Construction and demolition waste	46	75
Adaptive reuse	41	45
Sustainable development	35	44
Reuse	34	53
Recycling	30	60
Construction	22	44
Construction industry	21	43
Built environment	18	39
Construction waste management	18	19
Construction waste	16	21
Sustainable construction	16	27
Buildings	15	27
LCA	14	24
Building materials	12	20
Concrete	12	20

4.4 Research Outlets

The research outlet analysis (*Fig. 5*) reveals notable variations in the impact and influence of different journals. The "Journal of Cleaner Production" stands out with 43 articles and 2,790 citations, averaging 65 citations per article and a high total link strength of 120. This suggests it is a major hub for discussions on sustainability and circular economy practices (*Table 3*). By contrast, the "IOP Conference Series: Earth and Environmental Science" has 33 articles but a lower average citation rate of 21 and a minimal total link strength of 6, indicating a more peripheral role in the research landscape. "Resources, Conservation, and Recycling" also demonstrates significant impact, with 17 articles generating 1,682 citations (average 99 per article) and a total link strength of 44, highlighting its influence on material efficiency and resource management. In contrast, journals like "Lecture Notes in Civil Engineering" and "Buildings" show lower citation averages

and link strengths, indicating more niche or emerging roles in the field. Overall, the link strength in the network emphasizes how interconnected and central some journals are in shaping research trends, while others play a more specialized or developing role.

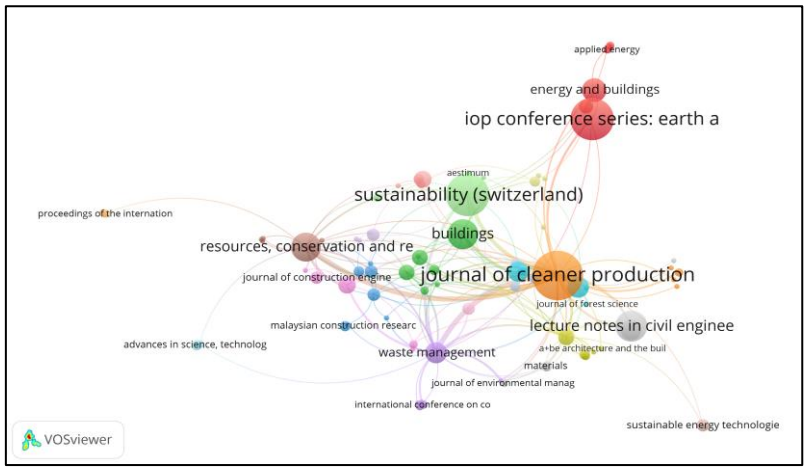

Fig. 5 Network of Landmark Research Outlets

Table 3 Research Outlets in Circular Economy and Sustainable Building Practices

Research outlet	No. of articles	Total citations	Av. citations	Links	Total link strength	Av. norm. citations
Journal of Cleaner Production	43	2790	65	44	120	2.55
IOP Conference Series: Earth and Environmental Science	33	224	21	3	6	0.27
Sustainability (Switzerland)	33	682	7	15	34	1.44
Lecture Notes in Civil Engineering	19	6	0	2	6	0.02
Buildings	18	141	8	8	15	0.81
Resources, Conservation and Recycling	17	1682	99	23	44	4.02
Energy and Buildings	12	651	54	5	6	1.89
Building And Environment	10	592	99	7	12	2.63
Waste Management	10	993	59	26	62	2.34
Journal Of Building Engineering	9	295	33	2	6	2.31
Sustainable Production and Consumption	9	88	10	6	13	1.31
Sustainability (Switzerland)	7	4	45	10	16	0.88
Sustainable Cities and Society	7	316	1	2	3	2.50
Clean Technologies and Environmental Policy	6	522	87	25	33	2.50

4.5 Major Circular Economy Research Areas

The following figure (*Fig. 6*) aids in better understanding these networks and creates a visual representation that is easy to follow and clarifies the main research areas. The VOSviewer reveals a complex network of themes in circular economy activities within the building industry. The core theme is "sustainable development," with 214 occurrences, indicating its significant influence on research and implementation. Other major themes include "construction industry" (176 occurrences), "circular economy" (175 occurrences), and "waste management" (166 occurrences). The clustering shows strong associations among "recycling," "construction waste," and "industrial waste," reflecting environmental strategies. Economic considerations are indicated by terms like "supply chains" and "business models," while social implications are connected to "human," "communities," and "social equity." Smaller clusters include "architecture," "energy use," "thermal comfort," and "heritage conservation," showcasing niche areas in sustainable building practices. This network highlights the multidisciplinary nature of circular economy research in the building sector, integrating various sustainability aspects for holistic development.

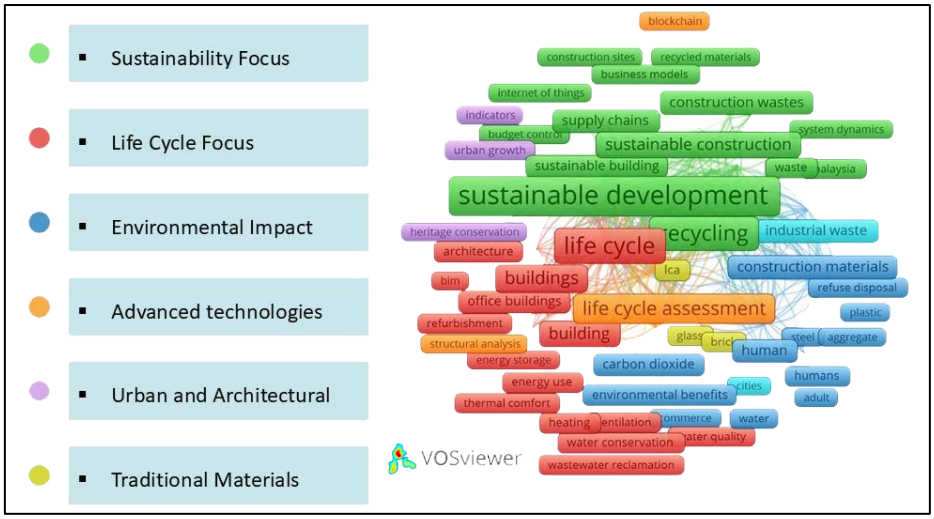

Fig. 6 Clusters of Main Research Areas.

5. Conclusion

The bibliometric review of circular economy (CE) practices in the building sector highlights significant research trends with practical implications for policy and real-world applications. The rising academic focus on sustainable practices, reflected in keyword occurrences like "circular economy," "sustainability," and "material efficiency," underscores the growing recognition of CE's importance in addressing environmental challenges in the building industry, which significantly contributes to global energy consumption and emissions. These trends suggest that policymakers can harness the growing body of research to develop regulations and incentives that promote sustainable building practices. For instance, policies could encourage using recycled materials through tax benefits or establish penalties for excessive waste. The shift toward material efficiency further calls for standards promoting reuse and recycling, reducing the environmental impact of construction. Additionally, the collaborative nature of the research field, characterized by strong cooperation among researchers and institutions, offers a foundation for policymakers to integrate the latest findings into legislative frameworks, fostering the adoption of (CE) practices at a larger scale. Real-world applications are also becoming more evident. The increasing attention to sustainable techniques informs the creation of green building certifications and environmental standards, which have already been implemented in various regions. By aligning policies with these

emerging trends, governments can create more sustainable, resource-efficient, and resilient built environments. Looking ahead, future research should delve deeper into underexplored aspects of (CE) in the building sector. Specific areas include conducting environmental impact studies to quantify the reduction in greenhouse gas emissions and energy consumption achieved through (CE) practices, along with economic analyses assessing sustainable technologies' long-term financial benefits. Further exploration of the social implications, such as job creation and community engagement, is also necessary to understand how (CE) initiatives contribute to broader social sustainability. Additionally, research should focus on developing policy frameworks that support (CE) adoption and exploring government incentives and regulatory barriers. Technological innovations in materials and construction techniques that enhance sustainability, including advancements in material science for better recycling and reuse, represent another critical avenue for future inquiry. By addressing these key areas, future studies can provide a comprehensive understanding of CE's environmental, economic, and social impacts in the building sector, thereby guiding more effective policies and strategies for sustainable development.

6. Conflict of Interest

The author declares no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper

7. Funding

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