Journal of Civil Engineering and Urban Planning (2025)
Clausius Scientific Press, Canada

DOI: 10.23977/jceup.2025.070201
ISSN 2616-3969 Vol. 7 Num. 2

Visual Analysis of Carbon Emission Research during Building Demolition Utilizing CiteSpace and VOSviewer

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Keywords: CiteSpace; VOSviewer; Building Demolition; Carbon Emissions; Research Hotspots; Visualization Mapping

Abstract: This paper uses bibliometric and visualization analysis methods to systematically sort and analyze the research dynamics, hotspots, and trends in the field of carbon emissions during the building demolition stage. The research adopts two bibliometric visualization tools, CiteSpace and VOSviewer, and through the analysis of 3171 documents, finds that the research hotspots in the field of carbon emissions during the building demolition stage are mainly concentrated in carbon emission calculation, influencing factors, carbon emission reduction technologies, and policy formulation; interdisciplinary collaboration is particularly important in the research on carbon emissions during the building demolition stage, and the cross-integration of environmental science, policy formulation, management, and other fields provides new perspectives and methods for solving carbon emission problems. This paper provides a multi-dimensional analysis of research hotspots, trends, and collaboration networks for researchers in the field of carbon emissions during the building demolition stage, aiming to provide useful references for in-depth research on carbon emissions during the building demolition stage.

1. Introduction

With the increasingly severe global climate change issue, carbon emissions from the stage of building demolition, as one of the important sources of greenhouse gas emissions, have become a focus of international attention[1]. The energy consumption in the stage of building demolition occupies a significant proportion in the total energy consumption of the construction industry, thus developing its carbon emission reduction potential is of great significance for achieving global carbon emission goals [2]. In recent years, scholars from various countries have conducted extensive research on the calculation methods, influencing factors, carbon emission reduction technologies, and the implementation of green demolition policies at the stage of building demolition, accumulating rich literature achievements. However, facing the massive research data on carbon emissions from building demolition in various countries, it is necessary to systematically sort out the research dynamics in this field, identify research hotspots and trends, and empower subsequent research.

2. Data and Methods

2.1. Data Sources and Tools

Data for this study are sourced from the Web of Science (WOS) core database. During the retrieval, the title words were selected, with "Building carbon emission" and "Building demolition" entered as search terms. The citation index options were set to Science Citation Index Expanded (SCI-EXPANDED) and Social Sciences Citation Index (SSCI), with the time range set to 2013-2025.

To ensure the quality of the literature, conference papers, scientific and technological achievements, and papers published online were excluded, and an artificial screening was conducted on this basis to eliminate invalid and irrelevant literature to the keywords. In the end, a total of 3171 pieces of literature were obtained. These literatures are exported as Tab-separated values and save them as "download_XXX.txt".

2.2. Research Method

This study employs bibliometric and visualization analysis methods to sort and analyze the research on carbon emission measurement in the building demolition phase, generating knowledge graphs and knowledge lineages, and visualizing the research in this field in an intuitive, graphic, and visual manner. This study utilizes both CiteSpace and VOSviewer, two bibliometric visualization tools, to construct literature analysis maps, thereby visually presenting literature data information. CiteSpace is developed by Dr. Chen Chaomei from the Department of Information Science and Technology at Drexel University in the United States, capable of drawing maps of keyword co-occurrence, keyword time-series networks, and author collaboration relationships; VOSviewer, co-developed by Van Eck and Waltman from the Research Center for Science at Leiden University in the Netherlands, is suitable for analyses such as keyword co-occurrence, author publication density, and literature co-citation networks, both based on the JAVA platform [3]. The study uses CiteSpace version 6.3.1 and VOSviewer version 1.6.18.0 to sort out the dynamics and focal points of research on carbon emission measurement in the building demolition phase, summarizing its research trends.

3. Literature Visualization Analysis

3.1. Annual publication volume of literature

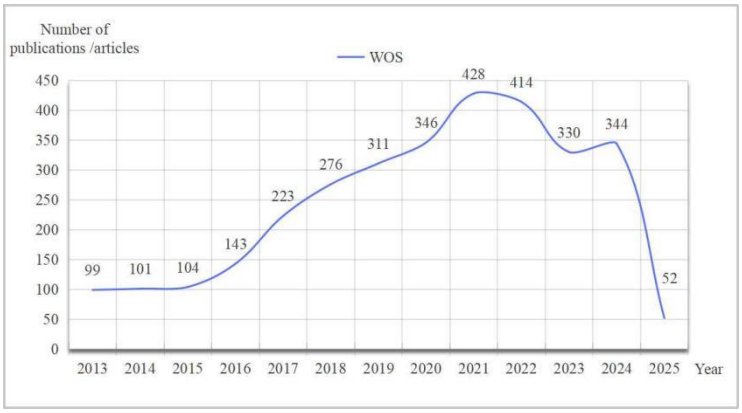

Figure 1: Graph of the number of published documents between years

As shown in Fig. 1, the annual output of literature can reflect the degree of attention and development of this research field, and the trend chart of the annual publication volume of carbon emission literature in the building demolition stage can intuitively observe the research trend in the field of carbon emission in the building demolition stage [4]. It can be seen from Fig. 1. that the number of relevant research papers on carbon emission in the building demolition stage is on the rise year by year. The research heat in this field is increasing year by year.

It can be observed from the analysis of the 3171 literature obtained that the number of publications in the field of carbon emission research during the building demolition stage can be divided into three stages over the past twelve years: the embryonic stage (before 2015), the growth stage (2016 to 2021), and the stable stage (since 2022). Among them, the year with the highest number of publications was 2021, with 428 papers.

3.2. Analysis of Research Hotspots and Trends

3.2.1. Keyword Co-occurrence

Keyword co-occurrence analysis is a pivotal scientometric method for uncovering research hotspots and trends [5]. In the keyword co-occurrence network, nodes represent keywords, and links denote their co-occurrence frequency [6]. Node size indicates keyword frequency, with larger nodes signifying higher occurrence rates.

Fig. 2 exemplifies this network for building demolition-stage carbon emissions. The central "carbon emissions" node (green) connects to numerous related terms like "CO_2 emissions", "carbon neutrality", and "life cycle assessment". Peripheral keywords such as "urbanization", "economic growth", "policy", and "climate change" exhibit weaker but significant correlations, highlighting the multifaceted impact of demolition-stage carbon emissions on urbanization, economics, and policy. The varied node colors suggest diverse, interdisciplinary research efforts extending from environmental to economic and policy domains.

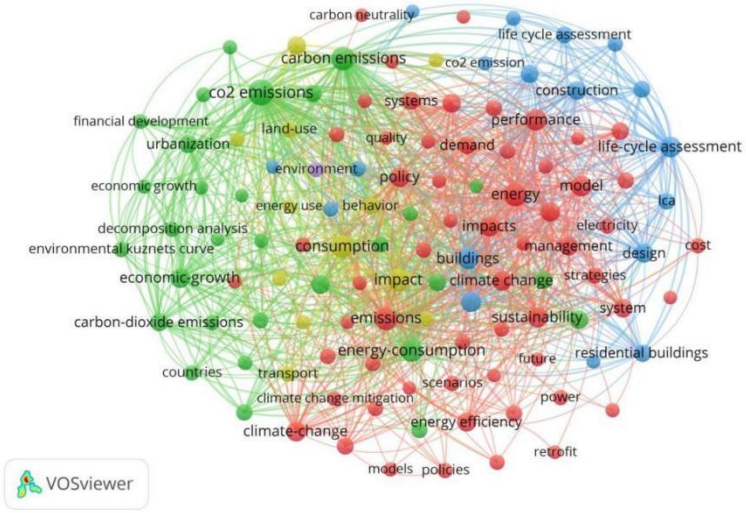

Figure 2: Keyword co-occurrence network diagram.

Fig. 3 presents the co-occurrence sequence of carbon emission keywords in the building demolition stage from WOS, with keywords appearing more than 5 times deemed significant [7]. The timeline spans from 2013 (blue) to 2025 (yellow), indicating the first appearance of each keyword.

Research hotspots like "low-carbon economy," "green building," and "whole life cycle" were

prominent from 2013 to 2022. Since 2022, the field has stabilized with no new major topics emerging. Key terms such as "carbon emissions," "energy consumption," and "sustainability" dominate, highlighting their centrality in the literature. Emerging keywords like "carbon neutrality" and "life cycle assessment" also feature prominently.

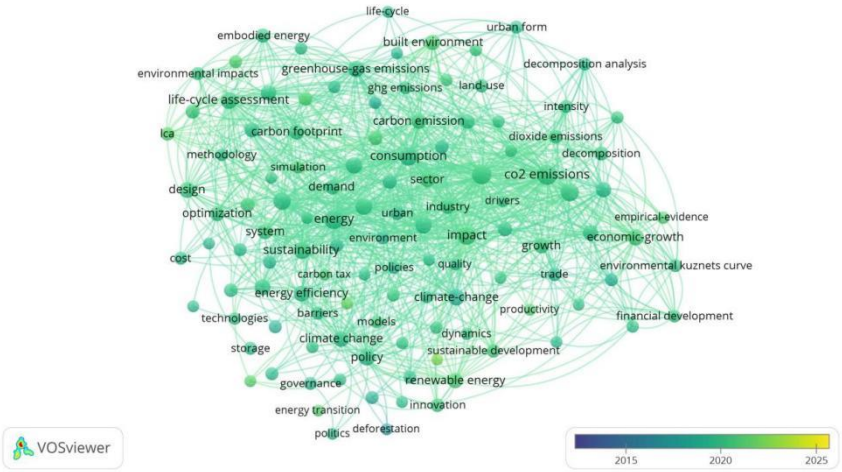

Figure 3: Keyword common current sequence map.

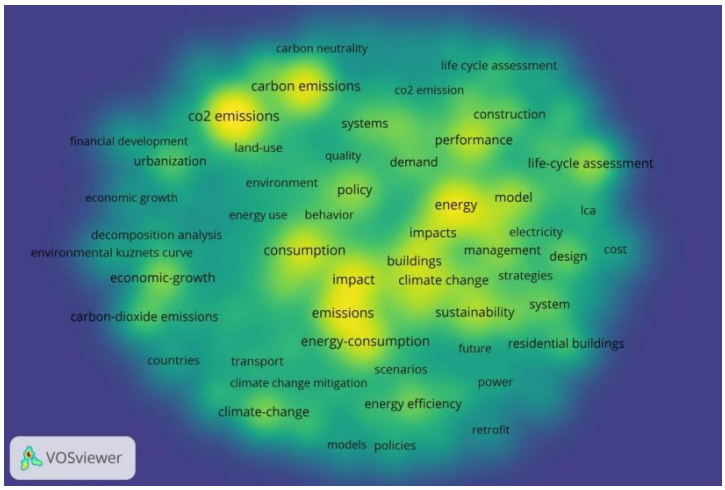

Figure 4: Keyword density map.

Fig. 4 illustrates the co-occurrence density map of carbon emission keywords in the building demolition stage, highlighting core themes such as "carbon emissions", "energy consumption", and "climate change". This visual representation underscores the current architectural research focus on reducing carbon emissions, enhancing energy efficiency, and addressing climate change, reflecting a growing emphasis on sustainable development and environmental protection[8]. Keywords like "economic-growth" and "urbanization" also feature, indicating a balanced approach to economic development and environmental stewardship.

The keywords cluster into distinct research areas, e.g., building energy efficiency and policy strategies. These clusters reveal interrelationships and overlaps, aiding researchers in identifying focal areas and potential gaps. Additionally, interdisciplinary keywords like "decomposition analysis", "environmental Kuznets curve", "policy", and "management" suggest the necessity of cross-disciplinary collaboration in tackling carbon emission challenges, integrating insights from environmental science, policy, and management[9].

3.2.2. Keyword Clustering

This analysis uses CiteSpace software to build a keyword co-occurrence matrix, calculate the similarity or correlation strength between keywords, and use clustering algorithms (such as spectral clustering, hierarchical clustering, etc.) to divide keywords into different clusters. Each cluster represents a specific research topic or subfield, and keywords within clusters are semantically highly relevant, while keywords between clusters are relatively independent [10].

In CiteSpace, select "Cluster" function to perform cluster analysis on the generated Chinese and English keyword co-occurrence network. Keywords are divided into different clusters using Louvain algorithm. CiteSpace automatically generates labels for each cluster, usually based on the Log-Likelihood Ratio (LLR) algorithm [11]. These tags help you understand the topic content of each cluster. In the keyword cluster analysis of WOS database, it can be seen from Fig. 5 that the keywords are divided into 15 categories according to the content of the clustering label: "carbon footprint" "carbon dioxide emissions" "urban form" "carbon reduction" "economic growth" "renewable energy", etc. In general, it can be concluded that the research hotspots on carbon emission in the building demolition stage mainly focus on carbon emission calculation in the building field and its influencing factors, the influence of building technology progress and social and economic development on carbon emission in the building demolition stage, and the response and feedback of building carbon emission reduction to environmental changes.

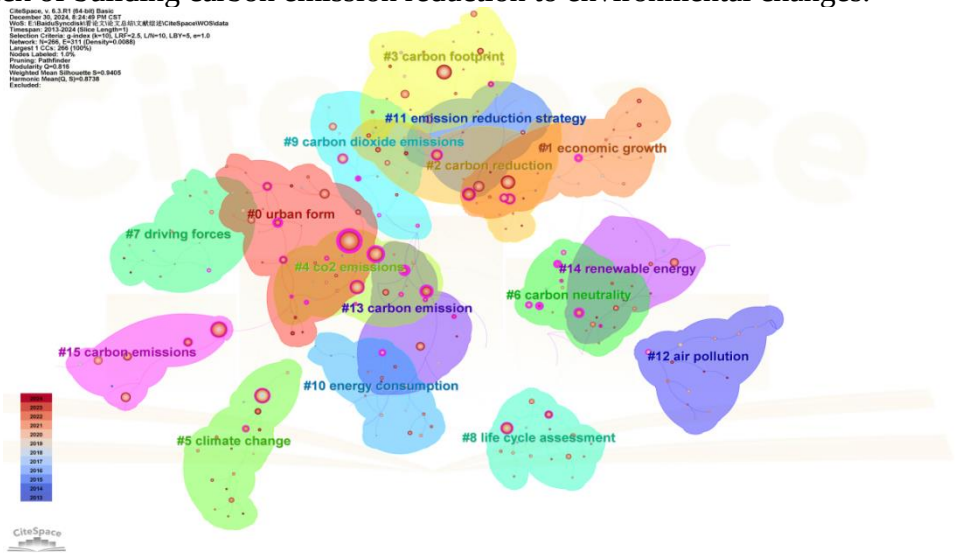

Figure 5: Key words Cluster graph.

3.2.3. Keyword Emergence

Keyword emergence, the temporal rise in keyword frequency, is a bibliometric tool for identifying research hotspots and trends [12]. Fig. 6 illustrates the emergence of English keywords on carbon emissions in building demolition, detailing each keyword's year, intensity, start, and end years. Since 2014, "climate change" and "energy use" have seen a marked increase in citations, becoming prominent topics. Over time, "greenhouse gas emissions", "CO_2", and "carbon dioxide reduction" have also gained traction, signaling a shift from emission sources and impacts to quantitative analyses. The emergence of "policy" and "challenges" highlights expanding research into policy formulation and implementation hurdles. Keywords like "input output analysis" and "scenario analysis" denote methodological innovations, offering fresh perspectives. In the past five years, "sustainable development" and "carbon neutrality" have emerged, underscoring growing

scholarly focus on these critical goals in building demolition carbon emission studies.

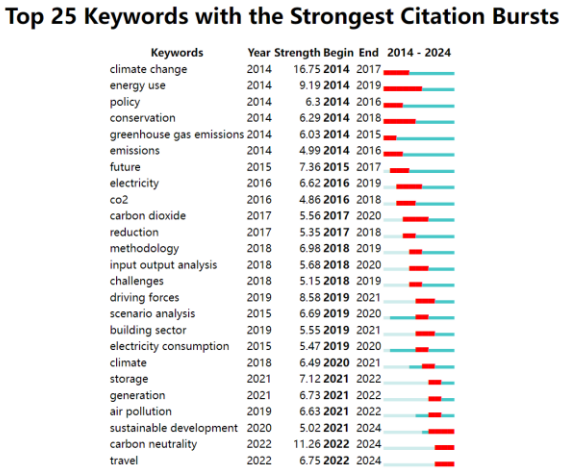

Figure 6: 2014-2025 literature keyword emergence map.

3.3. Literature Characteristic Analysis

3.3.1. Analysis of Literature Authors

This paper utilizes VOSviewer to analyze WOS data on carbon emissions during building demolition from 2013 to 2025, highlighting key research teams and their collaborative networks. Setting the cooperation frequency threshold to over 3 times in VOSviewer generates the author cooperation network and density maps (Fig. 7 and Fig. 8).

In Fig. 7, node size indicates the number of publications per author, and lines between nodes illustrate the extent of collaboration. The diagram reveals multiple collaborative clusters, each representing a distinct research team. Some authors appear in multiple clusters, signifying cross-team collaborations, with nodes of the same color denoting authors within the same team. Notably, the team led by Cai Weiguang and Shen Liyin exhibits a high level of collaboration, with Cai and Weiguang's team demonstrating the most frequent cooperation among the identified research groups.

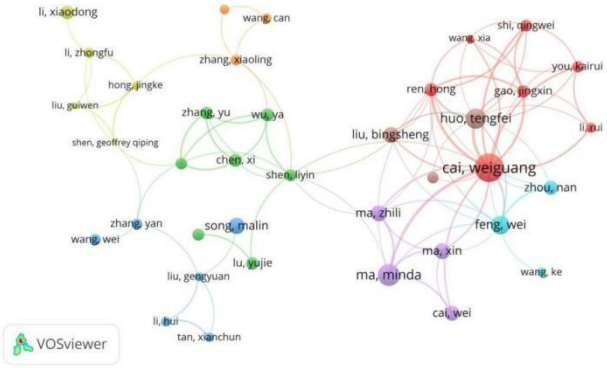

Figure 7: Map of the collaborative network of authors.

The author cooperation density map generated by VOSviewer (Fig. 8) was based on Multi-Dimensional Scaling (MDS) or similarity measurement, and the author nodes were spatially distributed according to the closeness of their cooperation relationship. In Fig. 8, the node name represents the author of the document, and the color warmth of the node reflects the frequency of the author's publication cooperation. The more yellow the color, the more frequent the author's publication cooperation, and the bluer the color, the less frequent the author's publication

cooperation. Through this map, we can intuitively identify the core group of authors, key partnerships and potential research cooperation opportunities in the field of carbon emissions in the building demolition stage, thereby promoting further knowledge exchange among scholars.

In Fig. 8, the collaboration of literature authors highlights a core group of highly connected authors cai, weiguang, who are relatively central figures in the literature collaboration network in this field. As can be seen from the figure, researchers from different groups are actively collaborating with each other. This cross-cluster collaboration is essential to address complex issues related to carbon emissions at the building demolition stage, which often require an interdisciplinary approach.

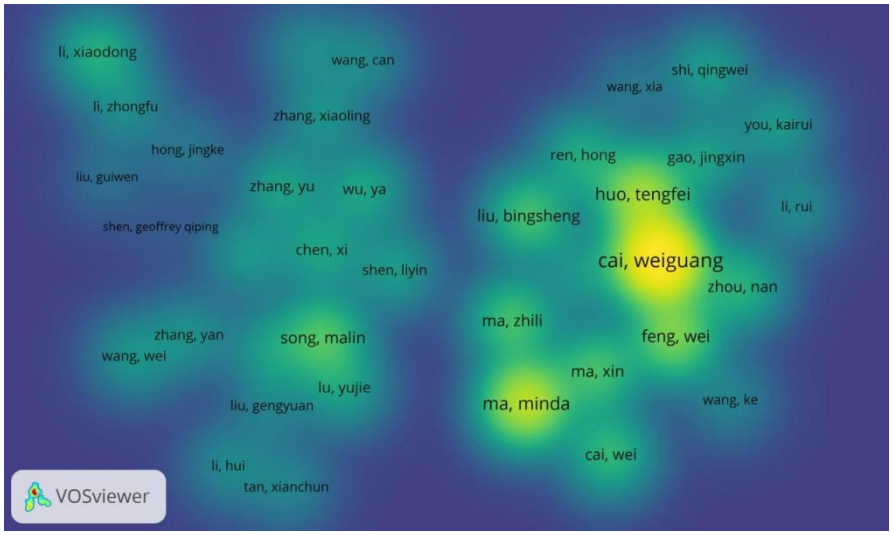

Figure 8: Density map of authorship.

3.3.2. Analysis of Literature Co-citations

Literature co-citation analysis is a quantitative analysis method used to study the cross-citation relationship between literatures. It reveals the correlation and similarity between a group of literatures by counting the number of times that two or two literatures in a group are simultaneously cited by other literatures [13].

The total citation analysis of literatures in the field of "Building demolition carbon emissions" retrieved based on WOS database is shown in Fig. 9 and Fig. 10. Each node in Fig. 9 represents a piece of literature, and the size of the node indicates the number of citations or its influence. The lines between nodes represent the citation relationship between documents, and the thickness of the lines reflects the intensity or number of citations. The three node colors of red, green and blue represent different research topics or subfields: red nodes represent literature related to low-carbon economy, green nodes represent literature related to environmental governance and climate change, and blue nodes represent literature related to energy control and corresponding policies. It can be seen from Fig. 9 to 10 that there are a large number of nodes in the literature and dense connections, indicating that the research on carbon emission in the building demolition stage is very active, and the research in its sub-fields is also closely related and complementary. At present, the English literature research on carbon emission in the stage of building demolition is more inclined to the direction related to environmental protection and energy control.

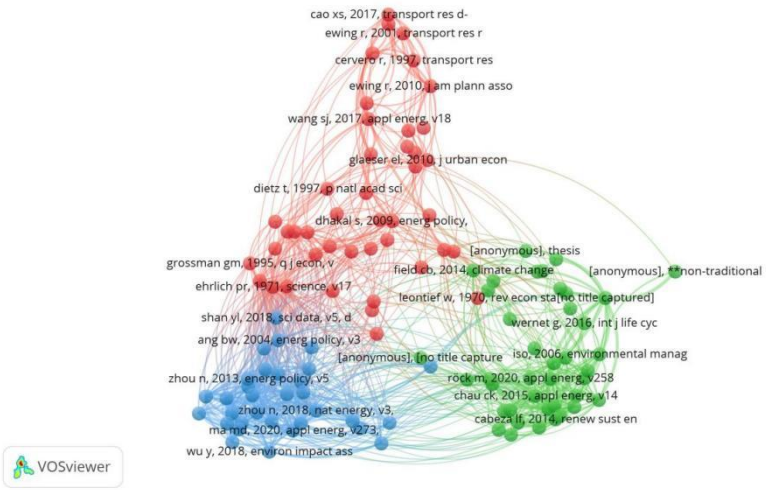

Figure 9: Diagram of the Co-citation Network in Literature.

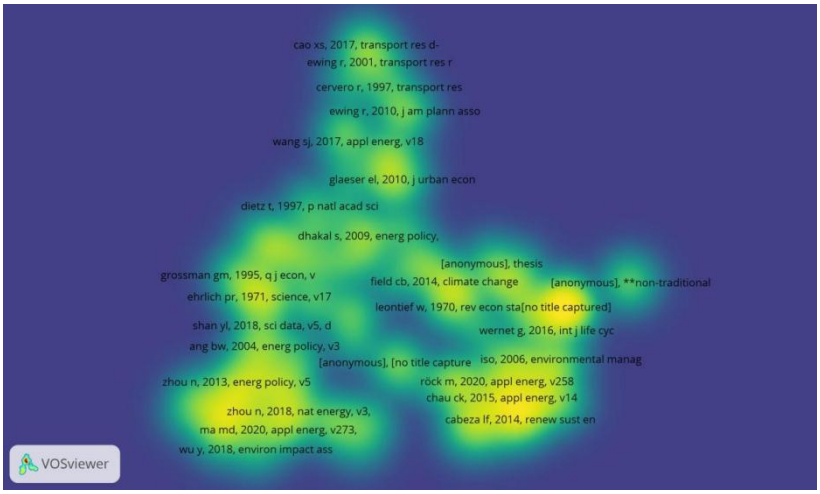

Figure 10: Density Map of Co-citation in Literature.

4. Conclusion and Recommendations

4.1. Research Conclusions

Utilizing CiteSpace and VOSviewer, this study systematically analyzed and visualized research on carbon emissions during building demolition, highlighting core themes, hotspots, and trends. Key findings include:

Research Hotspots: Focus areas are carbon emission calculation, influencing factors, reduction technologies, and policy formulation. Keywords like "carbon footprint," "carbon emission efficiency," "renewable energy," and "carbon neutrality" indicate a shift from traceability to quantitative research and policy implementation. Innovations in calculation methods (e.g., "input-output analysis," "scenario analysis") offer new tools, while "policy" and "challenge" keywords signify the growing importance of policy research.

Emerging Trends: Recent focus has shifted to "sustainable development" and "carbon neutrality," reflecting global priorities. The transition from "greenhouse gas emissions" to "carbon reduction technology" and "renewable energy" underscores deeper mitigation explorations.

Author Collaboration: Core authors like Cai Weiguang and Shen Liyin demonstrate significant

collaboration, emphasizing the importance of interdisciplinary cooperation, particularly between environmental science, policy-making, and management.

Literature Co-citation: Interconnections among low-carbon economy, environmental governance, climate change, and energy policy form a cohesive research network, highlighting the field's comprehensive nature.

In summary, this paper systematically reviews the research trends and hot spots in the field of carbon emission in the stage of building demolition through visual literature analysis. The results show that the field of carbon emission research in building demolition stage is developing towards multi-disciplinary, carbon emission policy-oriented research and technological innovation.

4.2. Research Prospects

Here are four perspectives from the study:

Enhancing Interdisciplinary Collaboration: Integrating insights from environmental science, construction engineering, social policy, and economics to foster innovative solutions [14].

Integrating Policy and Technology: Exploring the synergy between policy and technological advancements, evaluating policy effectiveness, and supporting low-carbon transitions in the construction industry [15].

Focusing on Emerging Topics and Methods: Prioritizing "carbon neutrality" and "sustainable development," and promoting advanced methods like "input-output analysis" and "scenario analysis" to enhance research accuracy.

Strengthening International Cooperation: Facilitating global collaboration to share research experiences, technologies, and policies, broadening research horizons [16].

In conclusion, the study of carbon emission in building demolition stage is a complex field of interdisciplinary interaction between technological progress and policy formulation. Through the visual analysis of the literature in this paper, a multi-dimensional perspective is provided for the research in this field, and it is hoped that these suggestions can provide useful guidance for future research and promote the sustainable development of the construction industry.

Acknowledgements

Supported by the “Education Department of Hebei Funding Project for Cultivating the Innovative Capabilities of Graduate Students” (Grant No. XJCX202510).

References

[1] Zejun Yu, Yao Wang, Bin Zhao, Zhixin Li & Qingli Hao. Research on Carbon Emission Structure and Model in Low-Carbon Rural Areas: Bibliometric Analysis. Sustainability15. 16(2023).

[2] Clyde Zhengdao Li, Yiqian Deng, Yingyi Ya, Vivian W. Y. Tam & Chen Lu. Applications of Information Technology in Building Carbon Flow. Sustainability 15. 23(2023).

[3] Ming Hu & Siavash Ghorbany. Building Stock Models for Embodied Carbon Emissions—A Review of a Nascent Field. Sustainability 16. 5(2024).

[4] Ren Feng & Liu Xiaolin. Evaluation of carbon emission reduction effect and porter effect of China's carbon trading policy. . Environmental science and pollution research international 30. 16(2023):46527-46546.

[5] Qingxuan Yu. International Green Finance Research Progress, Hotspot Analysis and Trend Outlook--Based on VOSviewer's Bibliometric Analysis. Financial Engineering and Risk Management 5. 6(2022).

[6] Xu Siyuan, Wang Junao, Sun Heng, Huang Liqiao, Xu Ning & Liang Yongtu. Life cycle assessment of carbon emission from natural gas pipelines. Chemical Engineering Research and Design 185. (2022):267-280.

[7] Jiaojiao Yang, Ting Wang, Yujie Hu, Qiyun Deng & Shu Mo. Comparative Analysis of Research Trends and Hotspots of Foreign and Chinese Building Carbon Emissions Based on Bibliometrics. Sustainability (13) 15. 13(2023).

[8] Huang Liqiao, Liao Qi, Yan Jinyue, Liang Yongtu & Zhang Haoran. Carbon footprint of oil products pipeline transportation. Science of the Total Environment 783. (2021).

[9] Zhu Enyan, Qi Qiuyu & Sha Mei. Identify the effects of urbanization on carbon emissions (EUCE): a global scientometric visualization analysis from 1992 to 2018. . Environmental science and pollution research international 28. 24(2021):31358-31369.
[10] Xu Siyuan, Wang Junao, Sun Heng, Huang Liqiao, Xu Ning & Liang Yongtu. Life cycle assessment of carbon emission from natural gas pipelines. Chemical Engineering Research and Design 185. (2022):267-280.
[11] Zeng Jingjing, Qu Jiansheng, Ma Hanqing & Gou Xiaohua. Characteristics and Trends of household carbon emissions research from 1993 to 2019: A bibliometric analysis and its implications. Journal of Cleaner Production 295. (2021).
[12] Yanyi Zhu & Youpei Hu. The Correlation between Urban Form and Carbon Emissions: A Bibliometric and Literature Review. Sustainability 15. 18(2023).
[13] Ren Feng & Liu Xiaolin. Evaluation of carbon emission reduction effect and porter effect of China's carbon trading policy. . Environmental science and pollution research international 30. 16(2023):46527-46546.
[14] Fan Jianqiang, Meng Xiaosha, Tian Jiaxin, Xing Conghui, Wang Chao & Wood Jacob. A review of transportation carbon emissions research using bibliometric analyses. Journal of Traffic and Transportation Engineering (English Edition) 10. 5(2023):878-899.
[15] Padhan Lakshmana & Bhat Savita. Interrelationship between trade and environment: a bibliometric analysis of published articles from the last two decades. Environmental science and pollution research international 30. 7(2023):17051-17075.
[16] Baowen Lou, Freja Nygaard Rasmussen, Samson Abate Degago, Eivind Schnell Juvik & Rolf Andr é Bohne. A BIM-based carbon footprinting of earthworks in road construction process. Environmental Impact Assessment Review, 110. (2025).