

A Bibliometric Analysis of Green Finance and Waste Management in Small and Medium Enterprises (SMEs): Insights from Indonesia

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ABSTRACT

This study aims to inform academics and policymakers by examining research trends on green finance and waste management in small and medium enterprises in Indonesia from 2000 to 2025, highlighting significant contributions and areas of focus. Using the PRISMA framework, a VOS viewer was used to illustrate the results of a bibliometric analysis of 10,208 articles from the Scopus database. The analysis identifies Indonesia as the top contributor, Matsumoto, T. as the most prolific author, and Universitas Indonesia as the top institution. The AIP Conference Proceedings and the IOP Conference Series Earth and Environmental Science were recognised as essential publication channels. While low-frequency phrases indicate potential avenues for future research, emerging study clusters highlight important subjects like waste management and SMEs. The analysis is restricted to English-language articles and Scopus data, excluding other databases and document formats. Future studies could use more resources and databases, such as Web of Science, Gephi, and Springer, to further understanding. This review offers innovative qualitative methodologies and comprehensive insights by mapping academic works on waste management and green finance in SMEs. Moreover, it lays the groundwork for future research on the circular economy and sustainable development. It is a valuable resource for researchers and practitioners seeking to address the challenges of green finance and waste management of SMEs in Indonesia and ultimately promote sustainable practices in the construction industry.

Keywords:

Bibliometric analysis, Green finance, SMEs, VOS viewer, waste management

ABSTRAK

Penelitian ini menelaah tren penelitian mengenai green finance dan pengelolaan limbah pada usaha kecil dan menengah (UKM) di Indonesia periode 2000–2025, dengan tujuan memberikan wawasan bagi akademisi dan pembuat kebijakan. Menggunakan kerangka PRISMA, analisis bibliometrik terhadap 10.208 artikel dalam basis data Scopus divisualisasikan melalui VOSviewer. Hasil penelitian menunjukkan bahwa Indonesia merupakan kontributor utama, dengan Matsumoto, T. sebagai penulis paling produktif dan Universitas Indonesia sebagai institusi terkemuka. Selain itu, AIP Conference Proceedings serta IOP Conference Series: Earth and Environmental Science teridentifikasi sebagai saluran publikasi penting. Analisis juga menemukan kluster kajian yang menyoroti isu penting seperti pengelolaan limbah dan UKM. Keterbatasan penelitian ini terletak pada penggunaan artikel berbahasa Inggris dan hanya bersumber dari Scopus. Penelitian mendatang disarankan untuk memanfaatkan basis data tambahan seperti Web of Science, Gephi, dan Springer. Secara keseluruhan, studi ini memberikan dasar penting bagi pengembangan riset tentang ekonomi sirkular dan pembangunan berkelanjutan.

Kata Kunci:

Analisis bibliometrik, Green finance, pengelolaan limbah, UKM, VOSviewer

INTRODUCTION

The emerging scope of green finance and sustainable waste management in Indonesia results from its expanding economy, environmental concerns, and government support for sustainability (Amelia Setyawati *et al.*, 2023). The SME sector of Indonesia stands as the vital foundation for the economic advancement of Southeast Asia since it creates substantial employment opportunities and drives GDP growth (Tambunan, 2022). However, Poor waste management remains a critical issue, especially for SMEs, who struggle to acquire sustainable solutions because of budget constraints and limited knowledge (Supriatna *et al.*, 2024). The emergence of green finance presents businesses with essential financial motivations that build investment capacities for implementing environmentally conscious business methodologies (Haryanto *et al.*, 2024). Green financial instruments, including green bonds, sustainability-linked loans, and environmental credit schemes, demonstrate this movement to unite economic expansion with sustainability (Thaliya & Amrina, 2023).

Indonesia has transitioned from its conventional funding practices toward green finance, renewable energy, and sustainable infrastructure development (Zen *et al.*, 2023). The transition serves both economic resilience needs and improves the waste management practices of SMEs (Sayaza & Tri Hartono, 2025). Sustainable waste management practices face barriers to adoption among Indonesian SMEs because these businesses experience funding challenges when implementing sustainable projects (Hakim & Fuad, 2024). Green financing instruments such as green bonds receive increased adoption from government support combined with regulatory structures, alongside financial incentives, according to Fitranty *et al.* (2025).

ASEAN member states are developing financial integration and regional cooperation through which they have boosted foreign investments directed towards green projects (Ordóñez De Pablos *et al.*, 2024). The ASEAN Green Finance Framework allows Indonesia to develop a unified financial environment that backs environmentally friendly operations for SMEs in waste management and circular economy (Tanchangya *et al.*, 2025). Such strategic reforms enhance Indonesia's environmental sustainability and reduce its dependence on resource-intensive practices, which protects long-term economic stability during changing climate conditions and worldwide economic instabilities.

Sustainability awareness at a global scale has created green finance as the essential environmental and economic catalyst for change, especially in developing economies like Indonesia. National economic development depends heavily on small and medium enterprises (SMEs), but these businesses struggle with hurdles in waste management because of financial limitations and insufficient technology. The sector of green finance, through renewable energy investments, sustainable waste practices, and environmentally conscious business methods, provides sustainable solutions for these problems (Zhang *et al.*, 2021).

Sustainable finance resembles digital connectivity by fostering entrepreneurial growth in emerging markets to enhance waste management performance in small and medium-sized enterprises. Economic resilience and sustainability success depend on green infrastructure investments that use environmentally responsible business models (Kaur *et al.*, 2023). SMEs' adoption of sustainable waste management practices remains limited because they face difficulties regarding access to green financing, regulatory hurdles, and a general absence of awareness from the business sector (Wulandari *et al.*, 2017).

Financial policies promoting green investments heavily depend on the stability of political circumstances and robust government institutions. The level of institutional strength and government incentive programs in a country proves essential to attracting sustainable investments, thus leading to enhanced waste management by SMEs (H.-S. Chen *et al.*, 2023). Understanding green finance and its relationship to governance and waste management practices drives policy development that supports financial mechanisms for Indonesian small and medium-sized enterprises (SMEs).

Thus, this study aims to conduct a bibliometric analysis of SMEs' green finance and waste management to identify key research trends, influential contributors, and evolving themes in the field. Doing so will provide policymakers, financial institutions, and businesses with insights to guide them toward more effective and sustainable waste management solutions. Using bibliometric methodologies, a descriptive literature analysis was conducted to identify the body of knowledge in this sector, focusing on SMEs, waste management, and green finance from 2000 to 2025. This was done to comprehend this concept, its evolution, and its contribution. Therefore, this paper aims to contribute to filling the gap in the bibliometric studies related to green finance and waste management with a focus on Small Enterprises in Indonesia within the 25-year period.

RESEARCH METHODS

The review aims to outline the extent of Green Finance and Waste Management in Small and Medium Enterprises in Indonesia, conducted over the previous 25 years. The investigation utilised bibliometric and graphical tools to achieve this goal. Furthermore, bibliometric analysis is based on monitoring research on a particular subject and displaying the findings using a range of characteristic analyses of these studies (Saleh *et al.*, 2024). Using pertinent publications from the Scopus database, the investigation revealed high-quality studies. Ten thousand two hundred eight articles on Green Finance and Waste Management in Small and Medium Enterprises in Indonesia were found in the first search using the "Topic" option, which was used to look for keywords in the title, summary, or keyword sections during the March 29, 2024 scan.

The search terms "Green Finance," "Sustainable Finance," "Climate Finance" or "Impact Investment" or "Social Finance" or "Carbon Finance" or "Renewable Energy Finance" or "Waste

Management" or "Circular Economy" or "Recycling" or "Waste Reduction" or "Zero Waste" or "SMEs" and "Small and Medium Enterprises" or "Startups" or "Entrepreneurship" or "Micro Enterprises" and "Indonesia" or "Southeast Asia" or "Developing Countries" acted as triggers for the English and open-access papers that were included in the study. Since Scopus offers sophisticated tools to visualize, analyze, and track study output in all subject areas, we have used it to obtain Green Finance and Waste Management on SMEs in Indonesian journals for this research. For example, we manually screened and removed irrelevant publications using the criteria listed in Figure 1 to ensure the relative significance of the examined publications to Green Finance, Waste Management, and SMEs. Two thousand one hundred eighty-five papers were thus left for additional analysis. The inclusion and exclusion criteria are listed in Figure 1. The analytical research framework is also shown in Figure 1.

The Bibliometrics Analysis

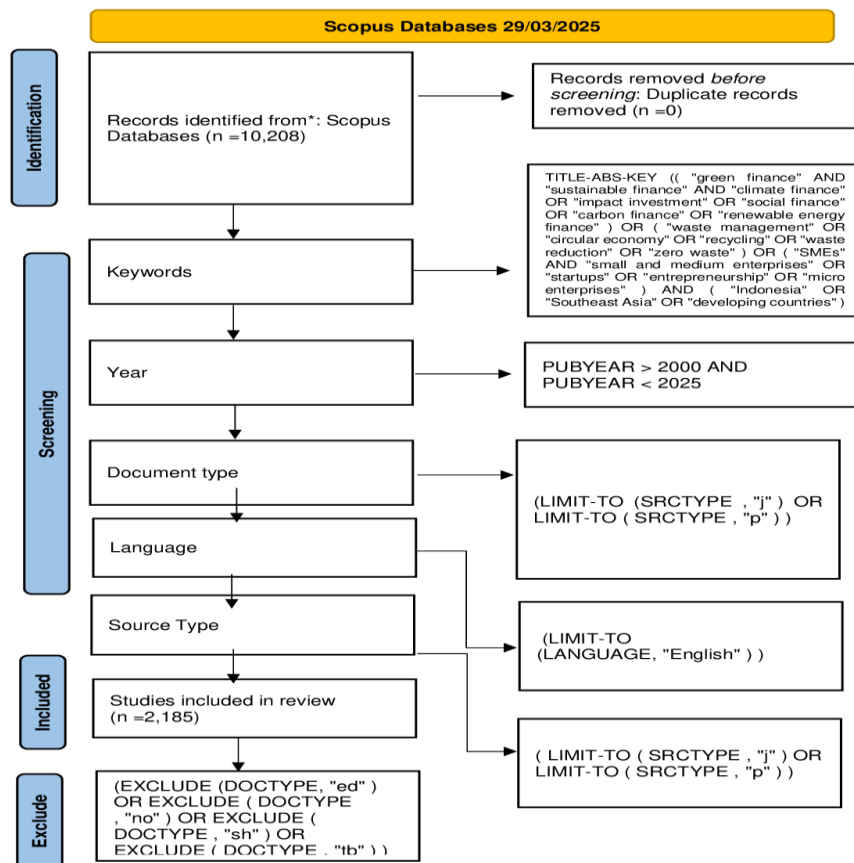


Figure 1. PRISMA Flow Diagram
 Source: Author's work (2025)

RESULT AND DISCUSSION

Bibliometric mapping is one of the primary research topics in bibliometric studies. Bibliometric mapping consists of two steps: (1) making a bibliometric map and (2) presenting maps visually. Creating bibliometric maps is the primary focus of bibliometric literature, with minimal attention paid to the graphical representation of maps (Beg *et al.*, 2024). In the past, bibliometric analysis was carried

out with various software applications, each with exceptional capabilities and restrictions. Although several bibliometric analysis tools are available, the most popular ones are HistCite, Publish or Perish, and Bibexcel (Saleh *et al.*, 2024). BibExcel was chosen for this study's bibliometric analysis because it is adaptable enough to make changes and edits to data imported from numerous databases, such as Web of Science and Scopus.

Furthermore, BibExcel can provide thorough data analysis with VOSviewer and other network analysis tools. We said that Scopus outputs were exported as RIS in the previous section (Exclusion and Inclusion). Consequently, the RIS form was obtained for analysis using BibExcel. Data collection and analysis are focused on the following areas (Marín-Rodríguez *et al.*, 2024).

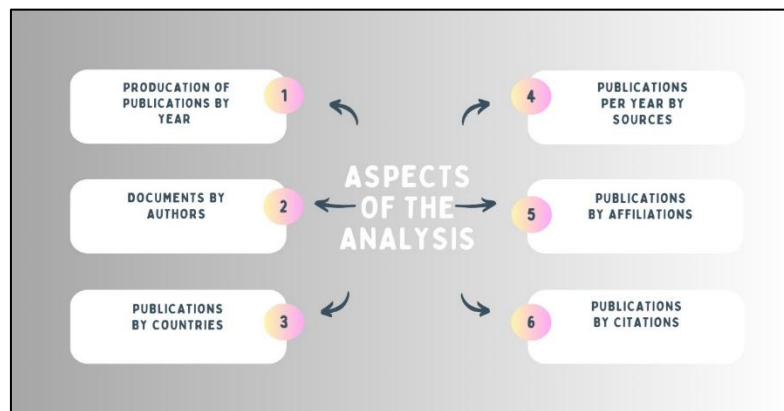


Figure 2. Features of Evaluating Extracted Articles
Source: Author created using Canva Mind Map (2025)

Distribution of Publications by Year

To address the first finding, the publication years of the articles during the previous 25 years were examined. A line graph was made to show the trend over time and identify the highs and lows in the publication activity. The number of papers published each year indicates the amount of research and interest in the topic. According to the data and graph, there has been a noticeable increase in publications, especially in recent years, from 2022 to 2024. This implies that the subjects discussed in these articles are gaining more recognition and attention from the academic and research community. The average number of papers published each year, or the publishing rate of the documents, is displayed in Figure 3. The publishing rate is calculated by dividing the total number of documents by the number of years. According to the data, 87.5 papers are released each year (Donthu *et al.*, 2021). This rate fluctuates yearly, though, so it is not constant. 2000, 2001, and 2004 had the lowest publication rates, with only one document apiece, while 2024 had the highest, with 442 papers (Ellegaard & Wallin, 2015).

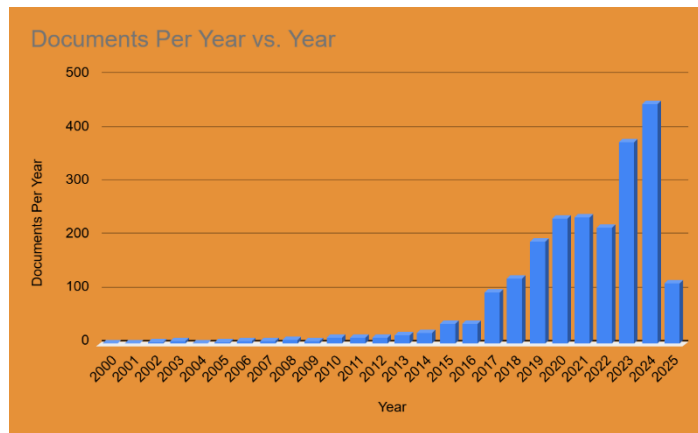


Figure 3. Distribution of Publications by Year (2000-2025)
 Source: Author's work (2025)

The Top 5 Highly Productive Journals

Table 1: The top 5 most productive journals on waste management and green finance in SMEs published in Indonesia over the past two decades, arranged by year (2000–2025).

Rank	Journal Name	Total Publications	Publisher	Cite Score	Total Citations	Most Cited Article	Times Cited
1	IOP Conference Series: Earth and Environmental Science	66,209	Institute of Physics Publishing	1.0	68,990	Correlation between conductivity and total dissolved solid in various types of water: A review	402
2	AIP Conference Proceedings	57,814	American Institute of Physics	0.5	28,862	Periodic table for topological insulators and superconductors	1,766
3	International Journal of Sustainable Development and Planning	1,000	International Information and Engineering Technology Association	2.2	2,249	Eco-cities: The mainstreaming of urban sustainability - Key characteristics and driving factors	157
4	Sustainability (Switzerland)	55,991	Multidisciplinary Digital Publishing Institute (MDPI)	6.8	381,357	Impacts of the COVID-19 pandemic on life of higher education students: A global perspective	1,229
5	Global Journal of Environmental Science and Management	216	GJESM Publication	7.9	1,697	Decolorization of mixture of dyes: A critical review	192

Source: Author's work (2025)

Our content study examined the top-referenced journals using the following standards: the journal's Cite Score, the most cited article, the total number of citations, the publisher, and the frequency of references. Table 1 displays the findings. With 66,209 publications and 68,990 citations overall, "IOP Conference Series: Earth and Environmental Science" was the most productive journal for Green Finance and Waste Management in Small and Medium Enterprises, as seen in Table 1 and Figure 4. "AIP Conference Proceedings," with 57,814 publications and 28,862 citations overall, and

"International Journal of Sustainable Development and Planning," with 1000 publications and 2,249 citations overall (Passas, 2024). Furthermore, Table 1 shows the distribution of the most productive journals related to waste management and green finance in Indonesian small and medium-sized businesses. However, RQ1 also looked into the most well-known writers in the field of study on Green Finance and Waste Management in Small and Medium Businesses in Indonesia. As indicated in Table 2, "Author," "Total Publications," "h-index," "Total citations," "current affiliation," and "country" were selected as the analysis criteria for the content analysis conducted for the prolific authors in the Green Finance and Waste Management in Small and Medium Enterprises in Indonesia research area.

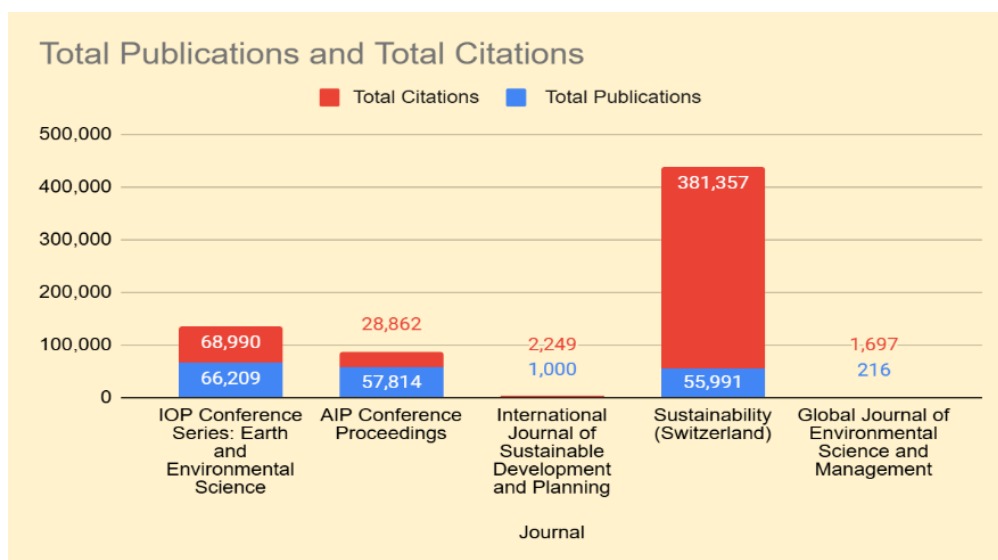


Figure 4. The Top 5 Scopus journals that support Waste Management, SMEs, and Green Finance
 Source: Author's work (2025)

Top 10 Highly Prolific Authors

Table 2 presents 15 highly productive authors in the relevant subject area of Green Finance and Waste Management in Small and Medium Enterprises. Furthermore, with 88 publications, an h-index of 11, and 709 citations overall, the Japanese author "Matsumoto Toru" was the most prolific. Next on the list is the author, "Ramadan, Bimastyaji Surya," from Indonesia. He has 795 citations, 110 publications, and an h-index of 16. It was followed by "Rachman, Indriyani," whose author is from Japan and has 56 publications, an h-index of 8, and 334 citations. Additionally, as determined by the number of publications, the top three stayed the same from an H-index perspective. Additionally, Table 2 displays data from other well-known writers in the subject area of Green Finance and Waste Management in Small and Medium Enterprises (Pitaloka *et al.*, 2024).

Table 2. List of the 10 most prolific authors in Green Finance and Waste Management in Small and Medium Enterprises in Indonesia

Author	Year of 1st Publication	Total Publications (TP)	h-Index	Total Citations (TC)	Current Affiliation	Country
Matsumoto, Toru	2002	88	11	709	The University of Kitakyushu	Japan
Ramadan, Bimastyaji Surya	2017	110	16	795	Universitas Diponegoro	Indonesia
Rachman, Indriyani	2017	56	8	334	The University of Kitakyushu	Japan
Ardi, Romadhani	2011	94	8	344	Universitas Indonesia	Indonesia
Suryawan, I. Wayan Koko	2018	126	18	1,027	Universitas Pertamina	Indonesia
Herdiansyah, Herdis	2016	169	14	660	Universitas Indonesia	Indonesia
Cordova, Muhammad Reza	2014	63	24	2,053	Badan Riset dan Inovasi Nasional	Indonesia
Budihardjo, Mochamad Arief	2011	170	16	890	Universitas Diponegoro	Indonesia
Damanhuri, Enri	2009	38	11	373	Institut Teknologi Bandung	Indonesia
Kristanto, Gabriel Andari	2011	48	7	279	Universitas Indonesia	Indonesia

Source: Author's work (2025)

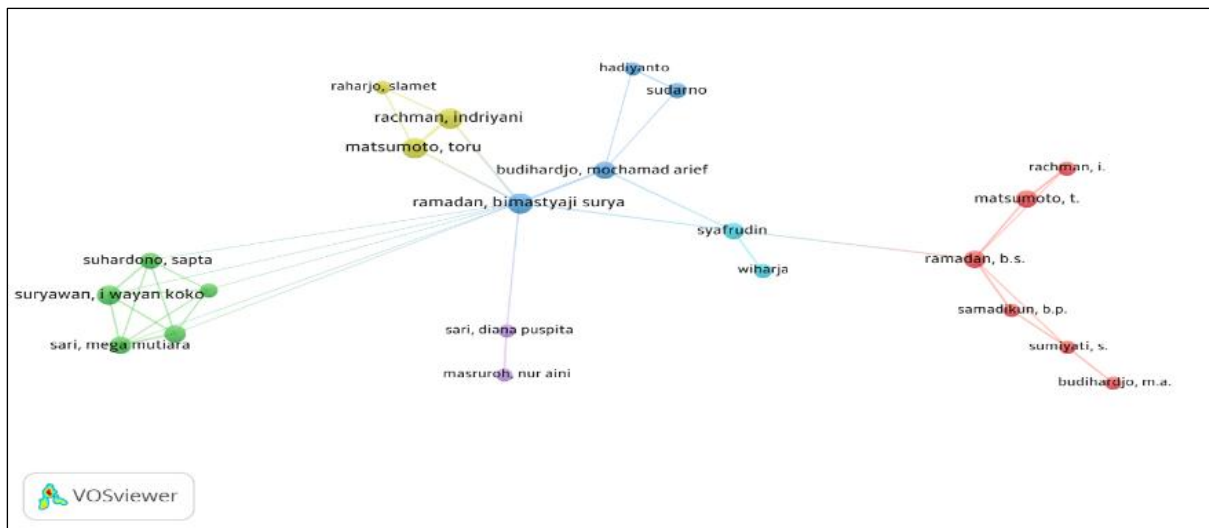


Figure 5. Co-citation of Prominent Author

Source: Author's work (2025)

Most Productive Countries

Table 3 and Figure 6 show the top 10 producing countries in the Green Finance and Waste Management in Small and Medium Enterprises study area and the topic distributions of the most productive countries, regions, and establishments. From a national standpoint, most countries and

in the data and graph. The size of the nodes can be used to gauge the volume of publications; larger nodes correspond to higher volumes of publications. Large nodes in nations like Australia, Malaysia, Japan, and Indonesia indicate that they publish a lot of material on the topic. The data and the image also show each country's publishing chronology, which is the duration or extent of the publications or research findings produced by that country. The publishing history can be shown using the colour of the nodes and edges; the years 2018–2023 are represented by a gradient from blue to yellow. More recent or increased publication activity in the relevant domains, such as Japan and Indonesia, is indicated by darker colours (H. Chen *et al.*, 2015).

Network Analysis

Network analysis can be done with various tools, but the most popular ones that scholars enjoy include Histcite Graph Creator, Pajek, Gephi, and VOSviewer. VOSviewer was chosen for this study because of its visualisation versatility and capacity to generate and present bibliometric maps. Users can construct and view linkages and genuine relationships using the program's text-mining capability. It makes sense for researchers and academics to use VOSviewer to create a comprehensive bibliometric map that shows the relationships between various components.

Network of Occurrence Keywords

The network of term occurrences represents research trends and study hotspots in a particular field (Tang *et al.*, 2018). A similar analysis is carried out to identify the words or phrases frequently included in the list of keywords or in the titles of publications being targeted. The discussion of keywords reveals how a particular field of study was developed by looking at the keywords used in the articles. Keywords also draw attention to the intellectual core of the article.

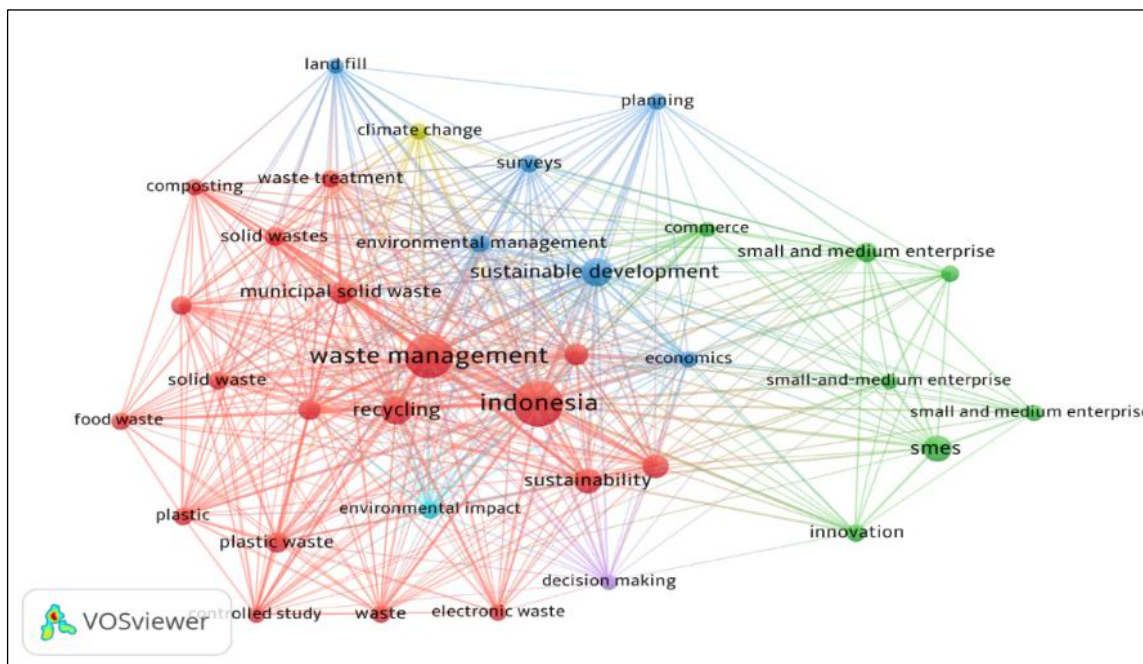


Figure 7. VOSviewer Analysis of the Top 40 Keywords
Source: Author's work (2025)

The type of analysis is co-occurrence; the unit of analysis is keywords; the counting method is complete counting. The results of the VOSviewer study show 9816 keywords in all articles on Green Finance and Waste Management in Small and Medium enterprises in Indonesia. Seven hundred fifty-five keywords meet this criterion when applying the minimum keyword occurrence requirement of 5. The minimal occurrence criterion is increased to 35 to highlight the most popular terms, and 40 keywords are chosen from the total pool. VOSviewer divides the top 40 keywords into six clusters, each identified by a distinct hue, as seen in Figure 7. Each cluster is limited to a certain number of objects or keywords.

Table 4. Top 40-Keyword Occurrence Analysis

Cluster	Color	Keywords	Occurrence (Frequency)	Total Linkage Strength
1	Red	Circular Economy (112), Composting (40), Controlled Study (35), Developing Countries (89), Electronic Waste (42), Food Waste (44), Indonesia (633), Municipal Solid Waste (87), Plastic (45), Plastic Waste (71), Recycling (168), Solid Waste (49), Solid Waste Management (55), Solid Wastes (55), Sustainability (118), Waste (51), Waste Disposal (79), Waste Management (543), Waste Treatment (51)	2,431 (sum)	5,195 (sum)
2	Green	Commerce (35), Innovation (47), Small and Medium Enterprises (69), Small and Medium Enterprises (40), Small- and- Medium Enterprises (35), TIME (38), SMEs (139)	403 (sum)	530 (sum)
3	Blue	Economics (42), Environmental Management (59), Land Fill (35), Planning (40), Surveys (48), Sustainable Development (172)	396 (sum)	1,135 (sum)
4	Yellow	Climate Change (38)	38	97
5	Purple	Decision Making (35)	35	92
6	Black	Environmental Impact (45)	45	128

Source: Author's work (2025)

Green finance and waste management in small and medium-sized businesses, the study's primary focus, are represented as key nodes in Clusters I, II, and III. A deeper look at the clusters reveals that, within the context of the map, the nodes of each cluster—that is, its keywords—show close relationships with one another. The keyword frequency rates within each cluster create the primary areas of focus identified in earlier studies. For example, Cluster I (red) highlights Waste Management and Financing (19 items), Cluster II (green) illustrates Small and Medium Enterprises (7 items), Cluster III (blue) illustrates Sustainability and Recycling (6 items), Cluster IV (yellow) highlights Climate Change (1 item), Cluster V (purple) highlights Decision Making (1 item), and Cluster VI (black) shows Environmental Impact (1 item). Each cluster highlights distinct study issues through its relationship with cluster keywords, indicating a significant research trend in the field of Green Finance and Waste Management in Small and Medium Enterprises.

Co-author Analysis

Most research projects need teamwork because one person alone cannot finish extensive studies independently. Scientific research initiatives heavily depend on efficient teamwork to obtain significant results. Bibliometric analysis strongly attaches to co-authorship studies because they show the degree

of cooperation between researchers in different fields. The degree of co-authorship between researchers reveals the degree of teamwork collaboration and the field's research development stage (Sharma *et al.*, 2022). The research investigates author and institutional co-authorship patterns by using VOSviewer software. The collaborative networks appear visually in Figure 9 (Cai & Guo,2021).

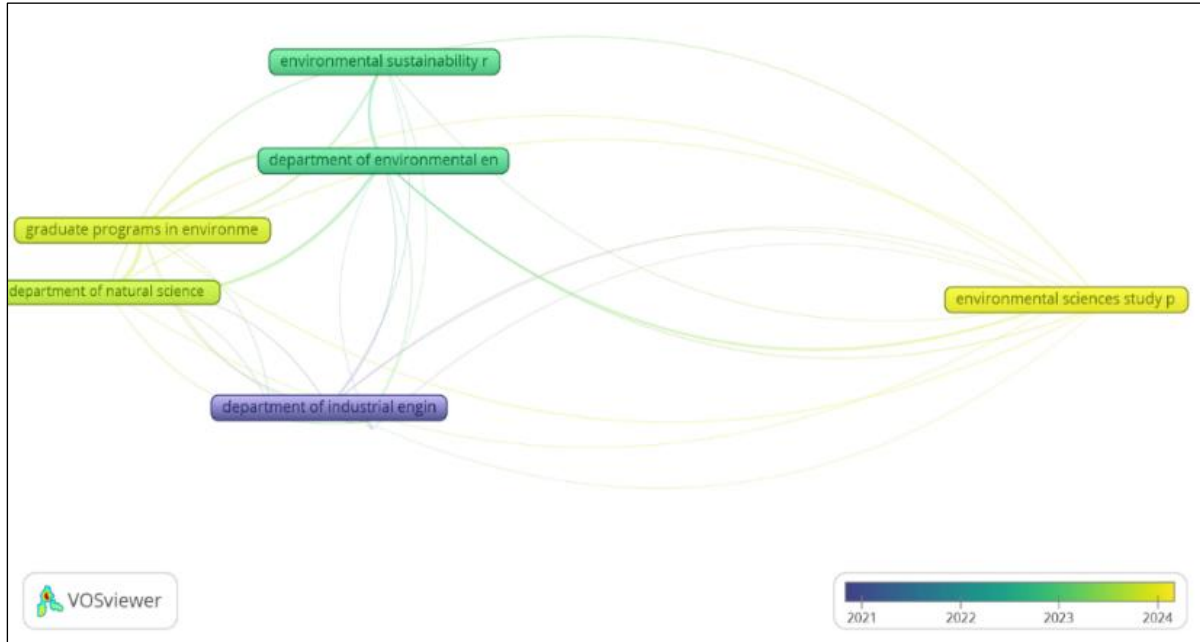


Figure 8. Co-authorship Network Visualization Map studies

Source: Author's work (2025)

CONCLUSION AND RECOMMENDATION

Green finance, which tackles the twin issues of promoting economic growth and halting climate change, has become vital in the global quest for sustainable economic development. This scientometric investigation shows the importance of green finance in promoting waste management in SMEs. This paper offers a thorough review of the development of green finance research. It offers important insights into how it might support sustainable business practices and spark the circular economy, making it a topic that is highly relevant to investors, researchers, and regulators.

The research production patterns of Green Finance and Waste Management in Small and Medium Enterprises were examined using bibliometric and network analysis, using insights from 25 years in Indonesia. More than 10,208 articles about green finance and waste management in small and medium-sized businesses were published between 2000 and 2025, according to publications included in the Scopus database. Using bibliometric and network analysis to identify the most important articles, new study clusters, and author collaborations is challenging despite the abundance of literature reviews on waste management in Indonesian small and medium-sized businesses. This advances the field of study by illustrating the connections between the most influential and highly ranked papers. It also provides an evaluation of the successful documents and other evaluation elements.

The findings of the study demonstrate the trends in green finance writing. The results show how far waste management and green finance research have come and how many countries, organizations, and publications have contributed. Several noteworthy pieces have been published between 2000 and 2025. The report states that waste management and green finance research in SMEs peaked in 2021, with the two most significant sources being the Journal of "IOP Conference Series Earth and Environmental Science" and "Aip Conference Proceedings." While Cordova M. and Suryawan I. received the most citations, Matsumoto Toru was the author with the most publications. The affiliate that contributed most to waste management and green financing in Indonesian small and medium-sized businesses was Universitas Indonesia, and the geographic distribution of publications showed that Indonesia had the most significant impact in this field.

In order to uncover important papers for further research, this study has recognized some of the recent green finance and waste management efforts. Identifying renowned scholars in green finance is crucial for establishing a foundation for further research. Table 3 presents the cluster analysis findings, identifying the primary study topics related to waste management and green finance in Indonesian small and medium-sized businesses, based on the significant connections between the terms within the clusters. However, keyword analysis indicates that low-frequency phrases indicate potential themes (topics) for additional study. It is one of the contributions of the research. The efficient use of VOSviewer for network analysis contributes to this study.

VOSviewer is not frequently used as a network analysis tool in green finance research. This work offers a manual for utilizing VOSviewer software for network and bibliometric research. There are definitely issues with how the study's results were arranged and presented. Some evaluation-related characteristics that were excluded from this study include the language of the articles (we only included English), the document kind (we excluded Editorial, Note, Short Survey, and Retracted), the publishing stage (we only included final), and the financial sponsor. The VOS viewer was used for this study out of the various network analysis tools available. This study recommends that future research be conducted using databases such as Publish or Perish, Web of Science, IEEE Xplore, and Springer, as it solely uses data from the Scopus database. Furthermore, since Gephi, Pajeck, and Hist Cite only accept data from the Web of Science, we advise future researchers to employ these and other network analysis tools..

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