


A Scientometric Analysis of Green Innovation and Business Models

Loso Judijanto¹, Juni iswanto²

¹IPOSS Jakarta

²Universitas Pangeran Diponegoro Nganjuk

Article Info	ABSTRACT
<p>Article history:</p> <p>Received September, 2025 Revised September, 2025 Accepted September, 2025</p> <hr/> <p>Keywords:</p> <p>Green Innovation Business Models Scientometric Analysis Circular Economy Digital Transformation</p>	<p>This study conducts a large-scale scientometric analysis of green business models and green innovation literature to map the intellectual structure, thematic evolution, and global collaboration patterns of this multidisciplinary science. Based on data drawn from the Scopus database from 2000–2025, the study employs VOSviewer software to perform co-authorship, co-citation, and keyword co-occurrence analysis. The results highlight four dominant thematic clusters centered around green innovation, circular economy, digital transformation, and green economy, revealing how these concepts have evolved and intersected over time. China, the United Kingdom, and India emerge as leading contributors, while institutions such as Jiangsu University and Xi'an Jiaotong University play pivotal roles in global research collaboration. The overlay and density visualizations show a surge of interest in digitalization, artificial intelligence, and ESG integration in recent years. The paper provides theoretical and empirical insights for researchers, policymakers, and practitioners aiming to understand and leverage the evolving forces behind sustainable business model innovation in the green transition era.</p> <p><i>This is an open access article under the CC BY-SA license.</i></p> <div></div>
<p>Corresponding Author:</p> <p>Name: Loso Judijanto Institution: IPOSS Jakarta Email: losojudijantobumn@gmail.com</p>	

1. INTRODUCTION

In the face of intensifying environmental challenges and accelerating climate change, the concept of *green innovation* has emerged as a cornerstone in reshaping the future of business practices. Green innovation refers to the development and implementation of products, processes, and practices that reduce environmental harm while driving economic value [1], [2]. Over the past two decades, businesses, governments, and academic institutions have increasingly recognized the dual necessity of ecological responsibility and economic

competitiveness. As such, green innovation is no longer a niche concern but a strategic imperative in global sustainability agendas, including the United Nations Sustainable Development Goals (SDGs) [3].

Parallel to the evolution of green innovation, *business models* have also undergone significant transformation. Traditional linear models are giving way to more circular, regenerative, and stakeholder-oriented frameworks [4]. Green business models seek to align environmental goals with financial returns, integrating principles such as eco-efficiency, renewable resource use, and closed-loop production [5]. These

models not only mitigate negative externalities but also offer firms a competitive advantage in markets that are increasingly sensitive to sustainability performance [6].

The convergence of green innovation and business models has catalyzed a dynamic field of interdisciplinary research. Scholars from environmental science, management, economics, and engineering have collectively advanced the theoretical and empirical understanding of how businesses innovate sustainably. The literature encompasses diverse themes such as eco-design, sustainable entrepreneurship, low-carbon technologies, green supply chains, and green value creation. However, the rapid proliferation of studies across journals and disciplines has also resulted in fragmented knowledge, making it difficult to capture overarching patterns, emerging trends, and collaboration networks in this field [7].

Scientometric analysis offers a solution to this fragmentation by quantitatively mapping the structure and evolution of scientific research. Through the use of bibliometric tools like VOSviewer, researchers can identify the most influential publications, key authors, core journals, co-authorship patterns, and thematic clusters in a given domain [8]. Such analysis not only uncovers the intellectual foundations of a field but also reveals its developmental trajectories and research frontiers. In the context of green innovation and business models, scientometric studies can provide valuable insights into how academic discourse has evolved, which topics are gaining momentum, and where future research might be directed.

Despite the rising importance of this intersection, few comprehensive scientometric reviews have been conducted to systematically assess the landscape of research on green innovation and business models. While individual reviews exist on related themes—such as sustainable innovation, environmental entrepreneurship, or circular economy—an integrated mapping of the scholarly output that bridges green innovation with business model

transformation is still lacking. Given the urgent need to scale sustainable solutions globally, such an analysis is not only timely but essential for aligning academic inquiry with policy and practice.

While the academic literature on green innovation and sustainable business models has expanded rapidly over the last decade, there is currently no consolidated scientometric analysis that captures the full scope, intellectual structure, and evolution of this interdisciplinary domain. This lack of synthesis limits our ability to understand the maturity of the field, identify influential works and emerging hotspots, and connect disparate strands of knowledge. Without such an overview, both scholars and practitioners may struggle to navigate the literature, detect gaps, and generate impactful research that supports sustainable transitions. This study aims to conduct a comprehensive scientometric analysis of the academic literature on green innovation and business models using bibliometric techniques and visualization tools, particularly VOSviewer.

2. METHODS

This study employed a scientometric analysis approach to quantitatively assess the structure, evolution, and trends in the scholarly literature on green innovation and business models. Scientometric methods are particularly suitable for evaluating the growth, impact, and interconnections within a research domain by examining bibliographic data such as citations, co-authorships, and keyword co-occurrences [8]. The study focuses on understanding how green innovation and sustainable business models have been conceptualized, researched, and disseminated within the academic community over time. The analysis aims to provide a high-level overview of the intellectual landscape, highlight emerging themes, and identify prolific contributors and collaborative networks.

The data collection was conducted using the Scopus database, chosen for its comprehensive coverage of peer-reviewed journal articles across disciplines. The search

query included combinations of keywords such as "green innovation", "sustainable innovation", "eco-innovation", "green business model", and "sustainable business model" in the title, abstract, and keyword fields. To ensure relevancy, only articles, reviews, and conference papers published between 2000 and 2025 were included. The final dataset was exported in .csv and .ris formats, containing bibliographic information such as author names, titles, publication years, source titles, affiliations, abstracts, and keywords. Duplicate records and documents not written in English were excluded from the analysis to maintain data quality and comparability.

3. RESULTS AND DISCUSSION

Co-Authorship Analysis

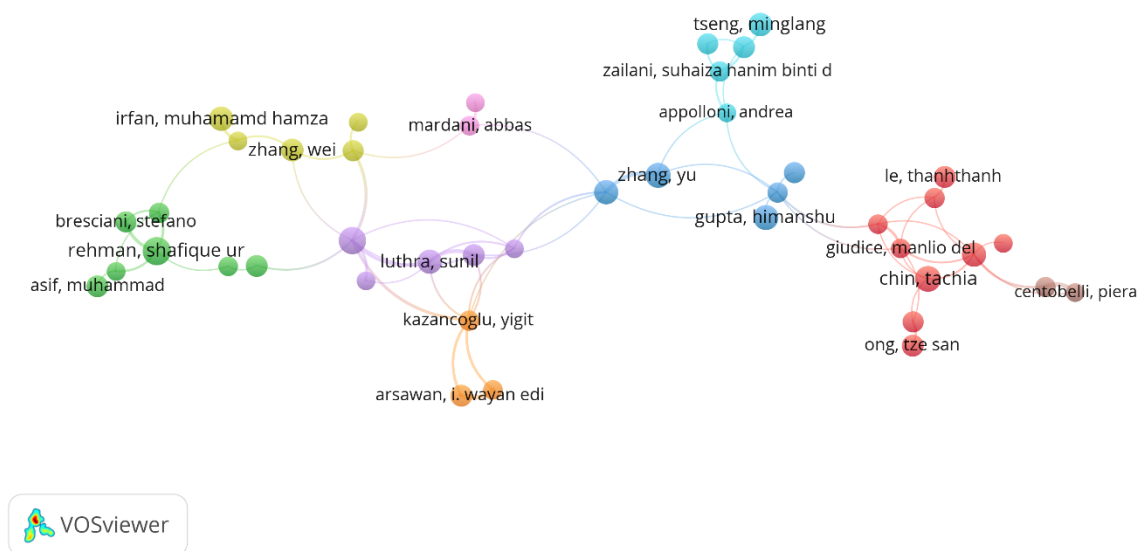


Figure 1. Author Visualization

Source: Data Analysis

Figure 1 illustrates co-authorship in the green business model and innovation research area with leading researchers and their co-authorship connections. There are color-coded clusters identified with different research groups or intellectual circles. For instance, the red cluster around Giudice, Manlio Del and Chin, Tzai Chi reflects a tight-knit co-authoring clique co-authoring together in the same thematic or institutional setting. Additionally, the blue cluster, led by researchers such as Zhang Yu and Gupta, Himanshu, indicates another crucial

The exported data were analyzed using VOSviewer, a widely used software tool for constructing and visualizing bibliometric networks. Three types of analyses were conducted: (1) co-authorship analysis to explore collaboration patterns among authors, institutions, and countries; (2) co-citation analysis to identify the most influential sources and documents; and (3) keyword co-occurrence analysis to detect thematic clusters and emerging research topics. Thresholds were applied to ensure clarity in the visualizations (e.g., minimum number of citations or keyword occurrences), and normalization techniques were used to enhance interpretability.

intersection of collaboration, potentially connecting East Asian and global sustainability scholars. Notably, Sunil Luthra is a central bridging scholar linking various clusters, suggesting his role in bridging otherwise non-overlapping scholarly communities. Other seeming clusters—such as green (e.g., Stefano Bresciani, Yigit Kazancoglu), purple (e.g., Minglang Tseng), and cyan (e.g., Yigit Kazancoglu)—mirror the splintered yet connected state of this research stream.

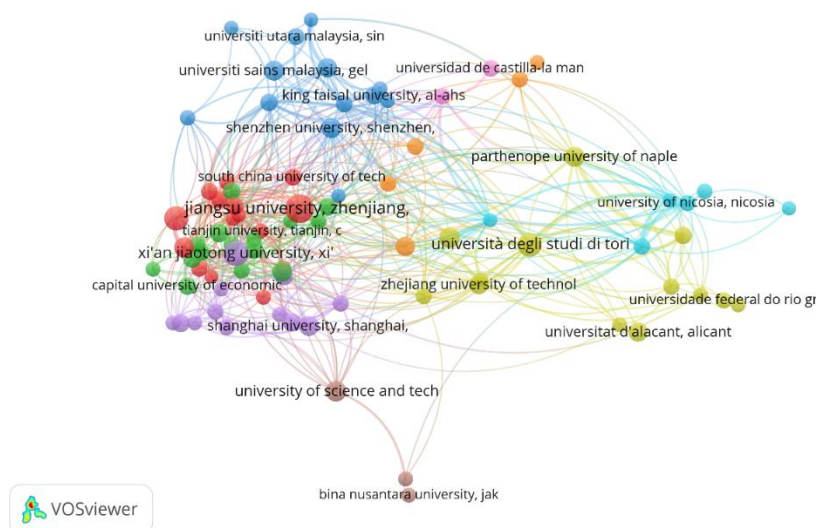


Figure 2. Affiliation Visualization

Source: Data Analysis

Figure 2 presents the institutional co-authorship network of green innovation and business models with collaborative relationships between institutions worldwide. Every colored cluster represents a set of institutions with strong in-group and out-group relations. Jiangsu University, Zhenjiang is represented as a central and highly influential node, which means it is an important institution in international research collaboration. It is closely connected to other Chinese institutions like Xi'an Jiaotong University, South China University of Technology, and Shanghai University, forming a dense East Asian cluster. European

institutions such as Università degli Studi di Torino, Parthenope University of Naples, and University of Nicosia are also prominent, indicating cross-continental collaborations, particularly between Asia and Europe. Furthermore, Southeast Asian and Middle Eastern institutions like Universiti Sains Malaysia and King Faisal University are represented with positive engagement. Of special interest is Indonesian Bina Nusantara University, while farther out on the periphery, but connected by a smaller brown cluster, revealing increasing engagement in this research topic.

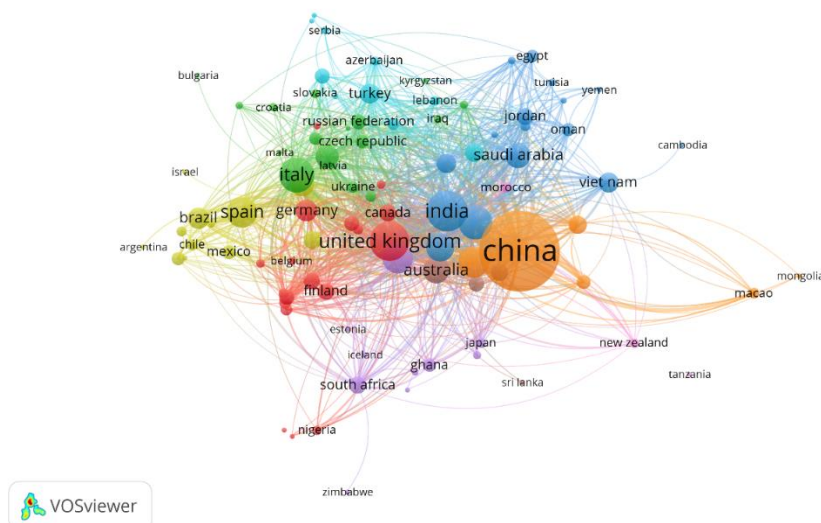


Figure 3. Country Visualization

Source: Data Analysis

Figure 3 illustrates a co-authorship country network in the area of green innovation and business models, in which the worldwide collaborative environment is unveiled. The nodes correspond to countries, and the node size symbolizes the volume of scientific output, with connecting lines signifying co-authorship ties. China is the most central and salient country, with enormous collaborative networks with the majority of nations in Asia, Europe, and elsewhere. Tightly clustered are India, Saudi Arabia, Australia, Vietnam, and Macao,

signaling strong local and foreign networks. European countries such as the United Kingdom, Germany, Italy, and Spain are also tightly clustered and well-connected, often working between and with Asian partners. United States, however, does not show up on the map at all, possibly dropped from the data or less central in this specific one. Growing alliances with South America (e.g., Brazil, Argentina) and Africa (e.g., Nigeria, Ghana) are indicative of a growing global participation in research focused on sustainability.

Table 1. Top Cited Literature

Citations	Author	Title
851	[9]	Implementation of circular economy business models by small and medium-sized enterprises (SMEs): Barriers and enablers
417	[10]	Sustainable consumption and production for Asia: Sustainability through green design and practice
199	[11]	Does it pay to go green? The environmental innovation effect on corporate financial performance
196	[12]	Corporate social responsibility, green innovation and competitiveness – causality in manufacturing
154	[13]	Leveraging blockchain technology for green innovation in ecosystem-based business models: A dynamic capability of values appropriation
123	[14]	Collaboration beyond the supply network for green innovation: insight from 11 cases
105	[15]	Expanding roles for the Swedish waste management sector in inter-organizational resource management
92	[16]	The effect of green HRM practices on green competitive advantage of manufacturing firms
89	[17]	Circular economy business models with a focus on servitization
70	[18]	Firm Sustainable Development Goals and Firm Financial Performance through the Lens of Green Innovation Practices and Reporting: A Proactive Approach

Keyword Co-Occurrence Analysis

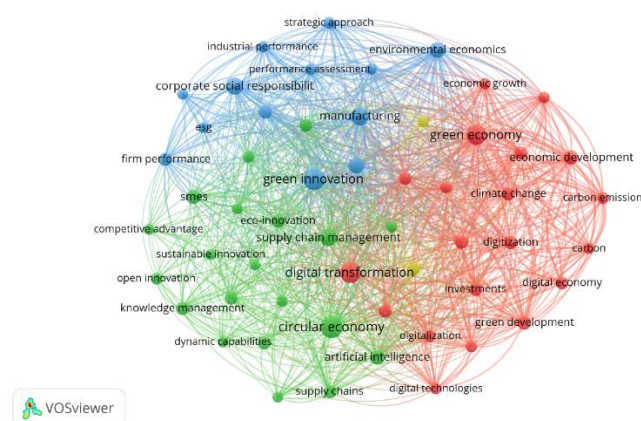


Figure 4. Network Visualization

Source: Data Analysis

Figure 4 above shows a keyword co-occurrence network of green innovation and business models research, delineating four large thematic clusters using color-coded clusters. Crucial bridging terms such as green innovation, digital transformation, green economy, and circular economy are found in the middle of the map, indicating their function as central glue for holding the various subfields together in this interdisciplinary research domain. The dense interlinkages reflect an integrated and mature literature where environmental sustainability, digital technologies, and economic growth are being explored together with one another. The green cluster (bottom-left) revolves around themes of green innovation, eco-innovation, sustainable innovation, open innovation, supply chain management, and competitive advantage. The cluster emphasizes the innovation capability of firms, particularly SMEs, in adopting sustainable strategies to competitive performance. It focuses on how firms leverage dynamic capabilities, knowledge management, and open innovation paradigms in developing green practices while maintaining profitability and responsiveness to emerging eco-aware markets.

The red cluster (right side) is focused on macroeconomic and policy-oriented themes. Green economy, economic development, climate change, carbon emissions, and digital economy are the

keywords that predominate in this cluster. It conveys a broad concern with systemic changes at national and international levels, addressing how climate policy, decarbonization efforts, and economic restructuring affect sustainable development agendas. In addition, investment and digitalization are viewed as facilitators of such green transformations, emphasizing the public-private synergies' role in climate adaptation and environmental governance. The blue cluster (top-left) explores organizational and performance dimensions of sustainability. Corporate social responsibility (CSR), performance measurement, industrial performance, and environmental economics are among the concepts clustered here, implying a research strand interested in measuring and managing sustainability initiatives. This includes how ESG frameworks and CSR initiatives influence firm-level outcomes and stakeholder perceptions, highlighting the importance of transparency, compliance, and strategic alignment of environmental goals with business operations. The yellow node at the intersection of all clusters, i.e., supply chain management, is a central link across the innovation, digitalization, and economic development narratives. Its central location indicates the fundamental role of supply chains in executing sustainability, as drivers and enablers of green transformation.

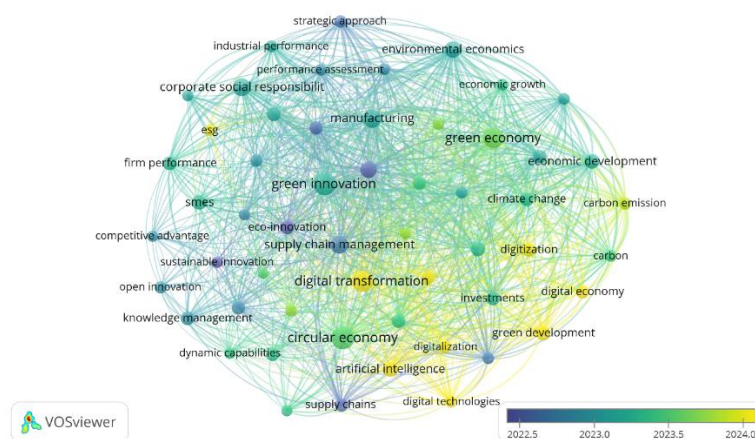


Figure 5. Overlay Visualization

Source: Data Analysis

Figure 5 here shows the temporal progression of green innovation and business model keywords, where color gradients indicate the median year of publication for each term. Blue to purple nodes (darker) indicate more frequent usage in older publications (circa 2022–early 2023), and brighter yellow nodes signify newer or emerging fields of research (mid to later 2023 through 2024). The key nodes such as green innovation, digital transformation, circular economy, and green economy are located in the lower key colors, which means they have been fundamentals and main areas of focus in the field for a couple of years.

Conversely, the peripherally ascending keywords like digital economy, green development, artificial intelligence, digital technologies, and carbon are yellow color-highlighted, indicating that they have gained newer momentum in scholarly

literature. These keywords show evidence of a shift towards including cutting-edge digital tools and climate-focused methodologies in the design of sustainable business models. The advent of AI and online platforms highlights the increasing confluence of technological innovation and environmental sustainability and sets the agenda for research oriented towards smart, data-led green transitions and their carbon neutrality and ESG performance consequences. Such temporal mapping also indicates a thematic maturity deepening, in which earlier discussion was focused on conceptual and performance-related foundations—like corporate social responsibility, performance measurement, and knowledge management—is increasingly being replaced by discussions of implementation at scale, especially through digitization, investments, and green development.

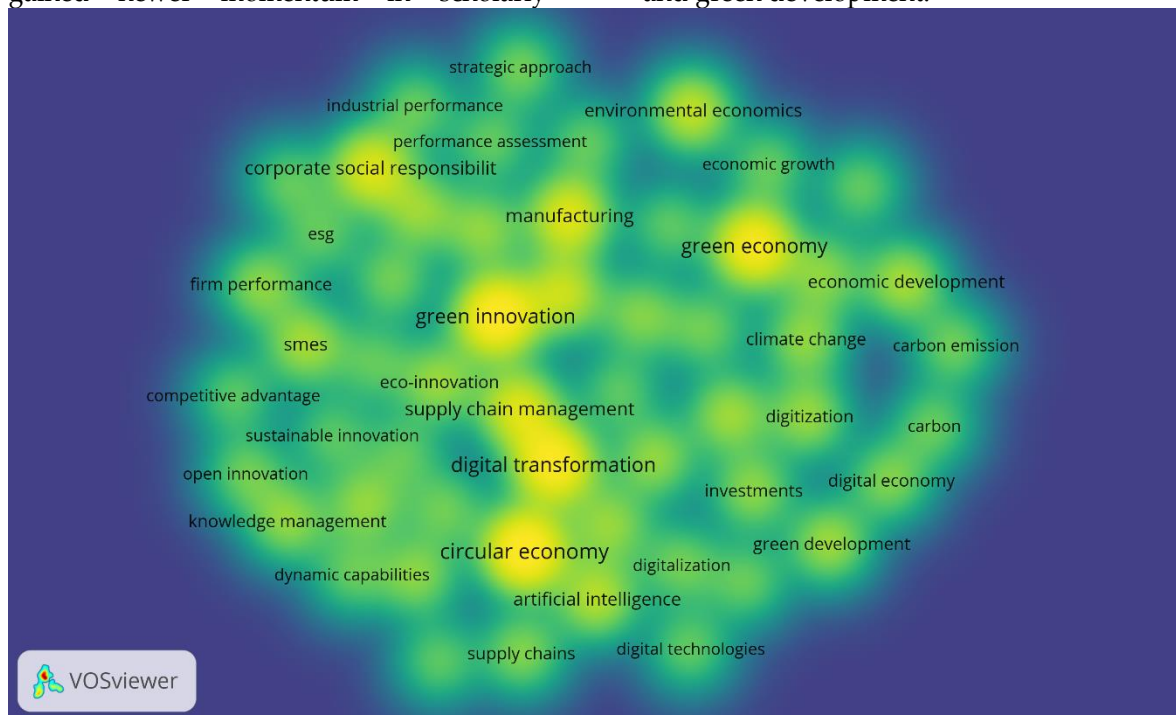


Figure 6. Density Visualization

Source: Data Analysis

Figure 6 above reveals the most intensively researched and frequently co-occurring keywords in the field of green innovation and business models. Brighter areas—shaded in yellow—indicate higher concentrations of keyword appearances and stronger interconnections, signifying central themes in the literature. Notably, terms such

as green innovation, digital transformation, circular economy, green economy, and supply chain management form the densest clusters, indicating that these concepts are at the heart of scholarly discussions and have consistently received substantial academic attention. Surrounding these core topics are moderately dense regions in green, including terms like

eco-innovation, firm performance, climate change, artificial intelligence, and digital economy. These keywords represent significant but slightly more specialized areas of inquiry that support the core themes. Meanwhile, outer areas shaded in dark blue and green—such as strategic approach, knowledge management, and open innovation—reflect emerging or peripheral topics that are either gaining attention or remain underexplored.

Practical Implication

The study provides helpful evidence for policymakers, corporate strategists, and innovation managers to navigate the ever-changing landscape of sustainable business models. Intellectual structure mapping and green business model research and green innovation collaborative networks enable the stakeholders to identify the most influential institutions, authors, and research clusters. This facilitates more informed decision-making in collaboration building, research funding allocation, and national innovation strategy building. Besides, the emerging focus on digital technologies such as artificial intelligence, digital transformation, and digital economies calls for emphasizing the convergence of technological agility with sustainability objectives. Firms can use the research to benchmark their sustainability procedures against the existing global trends and identify strategic options for embracing green and circular business models coinciding with regulatory needs and stakeholder expectations.

Theoretical Contribution

This scientometric piece adds to the literature by providing a systematic and holistic mapping of the development, organization, and thematic development at the intersection of green innovation and business models. As opposed to traditional or narrative literature reviews, this piece utilizes bibliometric and visualization techniques to extract implicit co-authorship patterns, keyword co-occurrences, and institution-level collaboration. The study reveals the intellectual roots of the field along with revealing nascent thematic clusters such as

the convergence of digitalization with sustainability, and the rise of ESG, supply chain decarbonization, and green innovation through artificial intelligence as novel theory horizons that are future-looking. By doing so, this research not only synthesizes existing knowledge but also lays the framework for successive research to spur the development of integrative theoretical frameworks on convergence of innovation management, environmental economics, and digital transformation.

Limitation

Although its wide scope, this study has a few limitations. One is that the analysis only covers the Scopus database, which is itself enormous but might miss important publications found in other archives such as Google Scholar, Web of Science, or disciplinary databases. Second, keyword co-occurrence and citation frequency can overlook the nuanced conceptual depth or critical nuance expressed in infrequently cited qualitative or theoretical work. Third, temporal coverage, as up to date as possible, may not capture the latest working papers or preprints within rapidly evolving fields such as AI-driven sustainability or green finance via blockchain technology. Lastly, clustering and visualization techniques, though forceful, are prone to algorithmic bias and prone to reduction of complex interrelations. Such limitations can be bridged in future studies through the use of multi-database inputs, qualitative content analysis, and longitudinal bibliometric designs for more textured knowledge.

4. CONCLUSION

This article presents a comprehensive scientometric analysis of the scientific literature on green business model innovation, revealing the intellectual structure, thematic evolution, and collaborative characteristics of the field. The findings demonstrate that green innovation has become a central theme in close relation with digitalization, circular economy, and green economy, reflecting growing convergence between sustainability and

technological advancement. Major authors, organizations, and countries were identified, showing a highly globalized and multidisciplinary field of research. Emerging trends such as artificial intelligence, digital technologies, and ESG matters illustrate the dynamic and forward-looking nature of

current scholarship. By distilling large-scale bibliometric data into comprehensible patterns, this study not only highlights the maturity and sophistication of the field, but also provides a strategic foundation for future academic scholarship and practical policy and industry use.

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