THEMATIC STRUCTURES AND RESEARCH STREAMS IN GREEN FINANCE AND SUPPLY CHAIN MANAGEMENT: A BIBLIOMETRIC ANALYSIS

Van Thuong CHAU
Faculty of Marketing and International Business, HUTECH University, Ho Chi Minh City, Vietnam
cv.thuong@hutech.edu.vn

Quoc Nghi NGUYEN
School of Economics, Can Tho University, Can Tho City, Vietnam
quocnghi@ctu.edu.vn

Quynh Lam NGUYEN
Faculty of Business Administration, HUTECH University, Ho Chi Minh City, Vietnam
nq.lam@hutech.edu.vn *(Corresponding Author)*

Abstract
This study maps the knowledge structure and thematic development of research connecting green finance and supply chain management through a bibliometric approach. The dataset was retrieved from the Web of Science Core Collection and refined using predefined inclusion and exclusion criteria to ensure relevance and data quality. Two complementary techniques were applied. First, bibliographic coupling was used to identify research fronts and group recent publications into coherent clusters based on shared reference patterns. Second, keyword co-occurrence analysis was employed to detect major themes, emerging topics, and their relationships across the dataset. The findings indicate that the literature concentrates on several interconnected domains, including green financial instruments and investment channels, green supply chain management practices, ESG and sustainability reporting, policy and governance drivers, and digital technologies that support transparency and traceability in supply chains. Building on the cluster structure and thematic patterns, the study proposes a forward looking research agenda, emphasizing future work on integrating green finance with supply chain decarbonization pathways, risk and resilience, and firm level adoption barriers. Overall, the study provides a structured overview that supports scholars in positioning future research and assists practitioners in aligning green finance initiatives with sustainable supply chain strategies.
Keywords: green finance; supply chain management; innovation; risk management; green supply chain.

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1. INTRODUCTION

At a broad level, green finance refers to economic activities that are built on decisions and behaviours intended to improve environmental quality and conserve natural resources, and it includes financial services related to investment, financing, project funding, environmental protection and ecological development (Zhao, 2023). From another perspective, it can also be seen as the process of channeling new social capital into green industries through a range of financial instruments such as green credit, green bonds, green funds, green insurance and carbon finance, with the central objective of improving the environment and supporting sustainable development (Chen & Zhao, 2023; Zhao, 2023). Recent studies further show that green finance plays a crucial role in encouraging sustainable activities and reducing negative environmental impacts, especially in the current context of climate change (Le & Le, 2024). Overall, green finance can be regarded as a financial mechanism specifically designed to support environmentally friendly economic activities, especially within supply chains, thereby advancing sustainable development and reducing ecological risks.

A supply chain is understood as a network of multiple organizations involved in production, transportation, warehousing, and the distribution of goods or services to end customers (Chopra and Meindl, 2001). The primary objective of the supply chain is to optimize costs and time in order to enhance the overall efficiency of the entire system. However, in the face of challenges arising from climate change and the demands of sustainable development, this traditional approach is gradually being extended into the concept of the green supply chain. A green supply chain integrates environmental factors into the entire product life cycle and across all stages of the supply chain (Fahim and Mahadi, 2022). This model is built on the principles of green

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production and green supply chain management techniques, aiming to optimize environmental performance, reduce waste and resource consumption, and simultaneously create sustainable value for both businesses and society (Zhao, 2023). Within this context, effective green supply chain management (GSCM) becomes a key factor in promoting sustainable practices, mitigating negative environmental impacts and improving firms' economic performance (Kholaif & Tang, 2025).

Green finance plays the role of a core supporting instrument that enables firms to implement green supply chain management (GSCM) in pursuit of sustainable development objectives. Specifically, green funding allows enterprises to invest in activities such as pollution reduction, waste treatment, renewable energy development and green logistics, all of which are critical components of GSCM (Fahim & Mahadi, 2022). Previous empirical studies show that the implementation of GSCM requires substantial financial resources for environmental technologies, innovation and supply chain collaboration (Zhu & Sarkis, 2004; Vachon & Klassen, 2006). In this context, green finance helps firms overcome capital constraints so that the greening of production and operations can be effectively realized. Evidence also suggests that green loans contribute to improving the operational efficiency of supply chains (Wang & Zhi, 2016), while green finance plays an important role in investment decisions and emissions reduction when firms face limitations in internal capital (Qin et al., 2018). Moreover, green credit not only encourages the adoption of low carbon technologies but also strengthens firms' financing capacity, thereby enabling supply chains to achieve dual performance in terms of both profitability and environmental outcomes (Che et al., 2021).

Accordingly, green finance can be positioned as a key enabling domain that is frequently discussed alongside sustainable supply chain practices and the broader green transition agenda. The literature indicates a close conceptual connection between green finance and green supply chain strategies, reflecting how financial instruments, policy initiatives, and sustainability-oriented investments are commonly framed as mechanisms that support the adoption of greener supply chain practices. In this perspective, green finance is consistently linked to discussions of environmental objectives, supply chain transparency, and operational considerations, highlighting a strong thematic association between green finance and supply chain outcomes across both scholarly and practitioner-oriented debates. Drawing on data collected from the Web of Science Core-Collection, this study applies two complementary bibliometric techniques. Bibliographic coupling is used to identify research streams and thematic clusters by examining shared reference patterns among publications, while keyword co-occurrence analysis is employed to map the thematic structure of the field and detect major themes as well as emerging topics. The synthesis of these analyses provides the basis for proposing an integrated conceptual framework and a future research agenda to guide subsequent empirical studies on green finance and supply chain management.

To achieve the objectives of this study, the following research questions are proposed,

RQ1. What are the main thematic structures and research streams in the green finance and supply chain management literature, as revealed through bibliographic coupling analysis?

RQ2. What major themes and emerging topics can be identified in this field based on keyword co-occurrence analysis, and how are they conceptually connected within the mapped literature?

RQ3. Based on the identified bibliometric thematic structures, what conceptual framework and future research agenda can be proposed for subsequent empirical validation?

2. METHODOLOGY

This study applies bibliometric analysis to provide a comprehensive overview and structured mapping of the knowledge landscape at the intersection of green finance and supply chain management. Bibliometric analysis examines scientific information networks using publication metadata, including authors, keywords, citations, and institutional affiliations, to generate visual maps that reveal relationships among research entities (Donthu et al., 2021). In these maps, nodes represent research entities, while link strength reflects the intensity of relationships among entities. Closely related entities are automatically grouped into clusters and distinguished by different colours to facilitate interpretation. VOSviewer was employed as the primary tool to visualise and analyse the knowledge network in a systematic manner.

Two complementary techniques were implemented. First, bibliographic coupling analysis was used to identify research fronts and thematic clusters by grouping publications that share similar reference patterns. Second, keyword co-occurrence analysis was performed to detect dominant themes, map conceptual linkages, and identify emerging topics within green finance and supply chain management research.

The bibliographic data were retrieved from the Web of Science Core Collection in September 2025. Therefore, records published after the data collection date were outside the scope of the analysis. The year 2025 was retained in the descriptive statistics as a partial year, and this limitation is explicitly acknowledged when interpreting the publication trend. The search was performed using the Topic field, covering title, abstract, and author keywords, to enhance precision and replicability. The search query was: ("green finance" OR "sustainable finance" OR "green credit" OR "green bond*") AND ("supply chain*" OR "supply chain management" OR "green supply chain*" OR "GSCM"). The search was restricted to English language publications to ensure consistency of the bibliometric analysis. Following data collection, a descriptive analysis was first conducted on the final dataset of 103 publications to summarise publication trends over time and identify the most productive countries, thereby providing an overview of the field's evolution and geographical distribution.

Subsequently, bibliometric mapping was performed in VOSviewer with predefined threshold settings to improve interpretability and reduce noise. To enhance replicability, the analytical parameters were specified for both bibliographic coupling and keyword co-occurrence analysis. Full counting was applied in both analyses to capture the complete linkage and occurrence structure within the dataset. The association strength normalization method was used to normalize link strengths and improve the comparability of relationships among documents and keywords. For network visualization, the default VOSviewer layout parameters were applied, with the attraction parameter set to 2 and the repulsion parameter set to 0. The minimum cluster size was set to 1 in order to retain small but potentially meaningful research fronts and keyword groupings in this emerging field.

For bibliographic coupling, the minimum number of citations required for a document was set to five, resulting in 46 documents being included in the coupling network. This technique was used to identify fine-grained research fronts based on shared reference patterns among publications. For keyword co-occurrence analysis, the minimum number of occurrences of a keyword was set to five, yielding 31 keywords for visualisation and clustering. This technique was used to detect dominant themes, conceptual linkages, and emerging topics within the green finance and supply chain management literature. Together, these analytical procedures provide a structured basis for interpreting the mapped themes and for developing the proposed conceptual framework and future research agenda presented in the subsequent sections.

3. RESULTS

3.1. Descriptive statistics of the studies

The first publication to examine the relationship between green finance and supply chains focused on how carbon emission reduction costs are shared among parties within the supply chain (Qin et al., 2018). Since that initial contribution, the field has attracted increasing scholarly attention. In particular, the period from 2022 to 2025 has seen a sharp rise in the number of related studies, reaching 30 publications by the time of data collection in September 2025 (Figure 1). Because the data were collected in September 2025, the publication count for 2025 should be interpreted as partial-year data rather than a complete annual total. This rapid upward trend suggests a growing concern within the academic community regarding the link between green finance and supply chains, while also reflecting the urgency and timeliness of this topic in the broader context of global sustainable development and climate change as an emerging critical challenge.

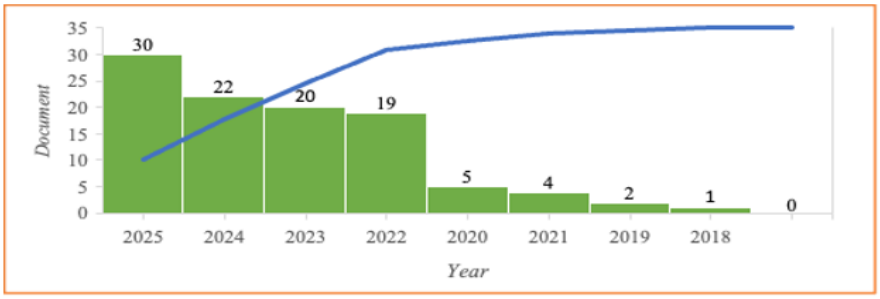

FIGURE 1- STATISTICS ON STUDIES OF GREEN FINANCE AND GREEN SUPPLY CHAIN MANAGEMENT DURING THE PERIOD 2018– SEPTEMBER 2025

The analysis shows that studies on green finance and supply chains are concentrated mainly in the United Kingdom and India, with 12 publications each, reflecting substantial efforts to promote sustainable development and to integrate green finance into supply chain activities (Figure 2). Malaysia, with 8 publications and Australia, with 6, also contribute notably to the field, indicating growing interest from the Asia–Pacific region. Overall, developed countries such as the UK, Australia, France and Italy tend to take the lead in developing theory and policy models, while developing countries including India, Malaysia, Egypt and Iran place greater emphasis on practical applications and impact assessment. This divergence helps shape a multidimensional picture of the relationship between green finance and supply chains within the broader process of global sustainable development.

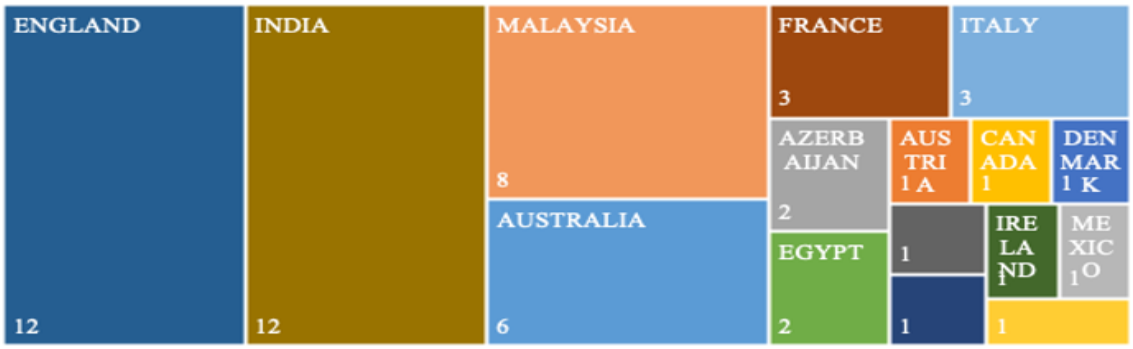

FIGURE 2 - COUNTRIES WITH PUBLICATIONS ON GREEN FINANCE AND GREEN SUPPLY CHAIN MANAGEMENT WORLDWIDE DURING THE PERIOD 2018– SEPTEMBER 2025

In the author analysis, prominent scholars such as Shan Yuli, Tian Jinfang, and Yu Longguang stand out as key researchers who have made substantial contributions to the study of the linkage between green finance and supply chains (Table 2).

TABLE 2 - LEADING AUTHORS IN STUDIES ON GREEN FINANCE AND SUPPLY CHAINS

Authors	Number of citations	Total link strength
Shan, Yuli	*388*	*368*
Tian, Jinfang	*388*	*368*
Xue, Rui	*388*	*368*
Yu, Longguang	*388*	*368*
Zhuang, Shan	*388*	*368*
Kumar, Anil	*211*	*2160*
Samadhiya, Ashutosh	*211*	*2160*
Agrawal, Rohit	*184*	*1742*
Agrawal, Shruti	*184*	*1742*
Cui, Herui	*184*	*288*

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3.2. Main research themes

3.2.1. Bibliographic Coupling Analysis

Drawing on the eight identified clusters, the author reviews the main content of each cluster by examining the titles, keywords, abstracts and the full text of open-access documents where available. On this basis, the dominant themes of the eight clusters can be summarized into the following eight topics (figure 3):

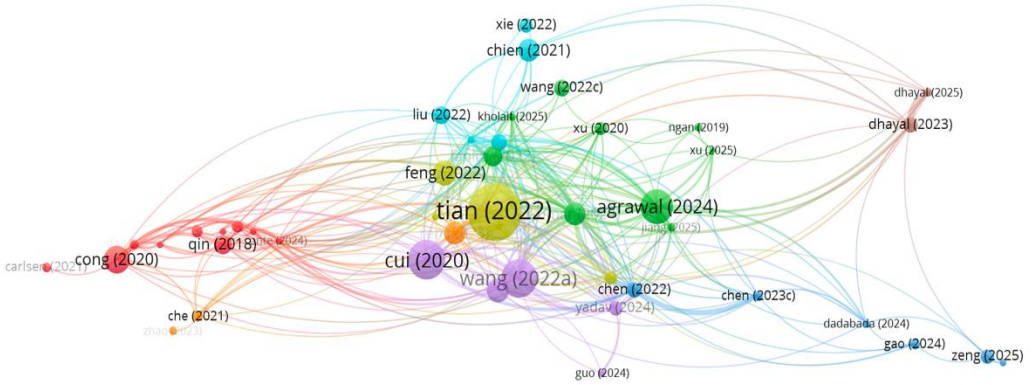

FIGURE 3 - BIBLIOGRAPHIC COUPLING ANALYSIS BY CLUSTER.

Table 3 presents the most influential publications identified within each bibliographic coupling cluster, highlighting the core studies that shape the major research streams in the green finance and supply chain management literature.

Red cluster: Green finance and ESG strategic integration

Publications in the red cluster mainly examine green finance and the mechanisms that encourage sustainable investment, including green bonds, ESG funds, CSR initiatives, financial support policies and ESG integration strategies. Four main research directions emerge from this body of work. First, Several studies examine the association between green finance and both financial and environmental performance, reporting positive relationships between green bonds, ESG funds, and indicators such as ROA and Tobin's Q (Ante, 2021; Qin et al., 2018). Second, a growing strand of research highlights the integration of ESG into corporate strategy as a key pillar shaping financial decision-making and strengthening competitive advantage (Pal et al., 2024; Yang et al., 2020). Third, another line of inquiry focuses on the role of policy and regulatory frameworks, underscoring the importance of a supportive policy ecosystem for the development of green bond markets in developing economies (Zhang et al., 2024). Fourth, green innovation is increasingly recognised as a critical driver of long-term value creation, with evaluation tools such as the Green Innovation Index becoming increasingly widespread.

Green cluster: Green finance, green innovation and circular economy

This cluster centres on how green finance, green innovation and the circular economy are integrated into green supply chain management with the overarching aim of promoting sustainable development. Green finance is generally seen as a key driver that supports technological, product and process innovation, thereby improving production efficiency and reducing environmental risk. At the same time, several studies point out that the effect of green finance on green innovation performance is still limited and tends to be unstable over time. Risk assessment in the implementation of green finance also remains an underdeveloped area, especially in sectors such as biomass, renewable energy and logistics, where more work is needed to capture specific risk profiles. To address these gaps, the literature suggests broadening evaluation models to incorporate the perspectives of multiple stakeholders, in order to strengthen the effectiveness of risk management. Most existing studies rely on descriptive analysis or decision- making techniques such as AHP and ANP, and there is a lack of integrated quantitative models capable of systematically assessing the relationships between green finance, green supply chain management, and sustainable performance. This highlights the need for composite

indicators that capture risk, reflect green innovation capability, and clarify how green finance is linked to sustainable supply chains. This points to the need for developing composite indicators that can assess risk, capture green innovation capability and quantify the contribution of green finance to sustainable supply chains.

TABLE 3 - INFLUENTIAL PUBLICATIONS IN THE ANALYZED CLUSTERS

Publications	Cluster	Total link strength	Number of citations
Tian, J., Yu, L., Xue, R., Zhuang, S., & Shan, Y. (2022). Global low-carbon energy transition in the post-COVID-19 era. *Applied Energy,* 307, *118205.*	4	4	387
Cui, H., Wang, R., & Wang, H. (2020). An evolutionary analysis of green finance sustainability based on multi-agent game. *Journal of Cleaner Production,* 269, *121799.*	5	21	183
Wang, K. H., Zhao, Y. X., Jiang, C. F., & Li, Z. Z. (2022). Does green finance inspire sustainable development? Evidence from a global perspective. *Economic Analysis and Policy,* 75, *412-426.*	5	27	176
Agrawal, R., Agrawal, S., Samadhiya, A., Kumar, A., Luthra, S., & Jain, V. (2024). Adoption of green finance and green innovation for achieving circularity: An exploratory review and future directions. *Geoscience Frontiers,* 15*(4), 101669.*	2	25	146
Cong, J., Pang, T., & Peng, H. (2020). Optimal strategies for capital constrained low-carbon supply chains under yield uncertainty. *Journal of Cleaner Production,* 256, *120339.*	1	16	86
Feng, H., Liu, Z., Wu, J., Iqbal, W., Ahmad, W., & Marie, M. (2022). Nexus between government spending's and green economic performance: role of green finance and structure effect. *Environmental Technology & Innovation,* 27, *102461.*	4	10	77
Li, Q., Sharif, A., Razzaq, A., & Yu, Y. (2022). Do climate technology, financialization, and sustainable finance impede environmental challenges? Evidence from G10 economies. *Technological Forecasting and Social Change,* 185, *122095.*	5	18	71
Chien, F., Ngo, Q. T., Hsu, C. C., Chau, K. Y., & Iram, R. (2021). Assessing the mechanism of barriers towards green finance and public spending in small and medium enterprises from developed countries. *Environmental Science and Pollution Research,* 28*(43), 60495-60510.*	6	9	61
Kumar, B., Kumar, L., Kumar, A., Kumari, R., Tagar, U., & Sassanelli, C. (2024). Green finance in circular economy: a literature review. *Environment, Development and Sustainability, 26(7), 16419-16459.*	2	30	59
Ren, Y. S., Ma, C. Q., Chen, X. Q., Lei, Y. T., & Wang, Y. R. (2023). Sustainable finance and blockchain: A systematic review and research agenda. *Research in International Business and Finance,* 64, *101871.*	7	22	59
Fahim, F., & Mahadi, B. (2022). Green supply chain management/green finance: a bibliometric analysis of the last twenty years by using the Scopus database. *Environmental Science and Pollution Research,* 29(56), 84714-84740.	2	52	51
Che, C., Chen, Y., Zhang, X., Zhao, L., Guo, P., & Ye, J. (2021). Study on emission reduction strategies of dual-channel supply chain considering green finance. *Frontiers in Environmental Science*, 9, 687468.	7	14	15
Jiang, L., Cao, X., Wang, Z., Zhan, Y., Zhang, J., & Chen, S. (2025). Promoting energy saving and emission reduction benefits in small and medium-sized enterprises supply chains through green finance-Evidence based on artificial intelligence intervention. *International Review of Financial Analysis,* 104112	2	30	10
Kholaif, M. M. N. H. K., & Tang, X. (2025). The role of green finance to achieve sustainability through green supply chain management and innovative technologies. *Sustainable Development*, 33(1), 1192-1211.	2	37	6
Yang, X., Song, Y., Sun, M., & Peng, H. (2020). Strategies for capital constrained timber and carbon sink supply chain under the cap-and-trade scheme. *Sustainability,* 12(11), 4380.	1	20	6
Da, B., Liu, C., Liu, N., Xia, Y., & Xie, F. (2019). Coal-electric power supply chain reduction and operation strategy under the cap-and-trade model and green financial background. *Sustainability,*11 (11), 3021.	1	13	12

Blue cluster: Green finance and technological innovation

Studies in the blue cluster examine how green finance is linked to high-tech stock markets under conditions of global volatility and crisis, with particular attention to the post-COVID-19 period. The main focus is on how risk is transmitted from large U.S. technology corporations such as Microsoft, Apple, Amazon, Tesla, Alphabet and Nvidia to green financial indices, including green bond indices and sustainability-linked products. Overall, the

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evidence suggests that green finance does not evolve independently of broader capital markets but is strongly influenced by movements in technology stocks, as reflected in growing patterns of risk clustering and tighter financial interconnectedness.

Within this strand of research, three main directions stand out. First, a number of studies seek to measure how green finance responds to technology shocks and extreme events, especially in the post-pandemic context. Second, researchers increasingly rely on advanced econometric tools such as Quantile VAR, Granger causality, Multiscale Spillover and Wavelet Coherence to trace volatility spillovers and tail risk. Third, some contributions propose hedging strategies based on portfolio structures that combine clean energy equities with crude oil futures. Despite these advances, most of the empirical work remains concentrated on the U.S. market, pointing to the need for further studies in emerging economies, particularly in Southeast Asia and China, in order to enhance practical relevance and diversify the empirical settings.

Yellow cluster: Green finance, government policy and energy transition

This cluster is concerned with the role of public expenditure and government policy in fostering green finance and green economic performance, with a particular emphasis on the post-COVID-19 period. The evidence to date suggests that government spending and public investment in renewable energy can make a positive contribution to green growth in countries involved in the Belt and Road Initiative (BRI). However, there is still a shortage of detailed empirical studies that disentangle how fiscal policy, green finance and sustainable economic performance are linked in practice. The COVID-19 pandemic is often described as a twin shock: it has created substantial economic and social disruption, but at the same time it has accelerated the push toward low-carbon energy, underscoring the urgent need to reorganise the global energy system. Against this backdrop, green finance appears as a key supporting tool, yet its potential is still constrained in many emerging and developing economies by a continued heavy dependence on fossil fuels.

Purple cluster: Fintech, green finance, and global sustainable development

Studies in this cluster explore the reciprocal relationship between financial technology (Fintech), green finance, natural resource governance, and sustainable development in the context of globalization and green transition. Fintech and green finance are regarded as important intermediary instruments that help expand access to green credit, enhance financial transparency, promote sustainable investment, and connect climate technologies and renewable energy with the financial system. At the same time, the literature highlights potential risks and paradoxes in real-world implementation in developing economies, particularly within multi-actor financial ecosystems involving governments, banks, and enterprises. Prominent research directions include: measuring the effectiveness of Fintech in expanding green finance; analyzing the long-term relationship between green finance and national sustainable development (the Green Finance–SD nexus); examining the linkage between climate technology, green bonds, and emission reduction outcomes; modeling multi-stakeholder coordination in the implementation of green financial policies; and proposing the integration of Fintech with sustainable supply chain management to optimize environmental and economic performance in service and logistics sectors.

Light blue cluster: Financial development, green credit and green economic growth

Studies in this cluster focus on the relationship between financial development, green credit and green economic growth, particularly in the context of industrialization and the transition to clean energy. A large number of studies use quantitative models to evaluate the role of the financial system in encouraging green investment and controlling emissions. Many of these contributions highlight a bidirectional relationship between green credit and industrial growth, suggesting that green credit not only discourages investment in highly polluting industries but also supports the expansion of low-carbon technologies. At the same time, the absence of stable and well-designed financial mechanisms in many developing countries means that these positive effects are often fragile and difficult to sustain over the long term. Panel data analyses further indicate that financial development can help reduce CO_2 emissions, although the strength of this link depends heavily on the quality of governance and national institutional frameworks. Evidence from China, India and Pakistan underscores that green financial policies must be adapted to the specific characteristics of each country's financial market, rather than applying a uniform policy model across different contexts.

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Orange cluster: Green finance and sustainable economic growth

This cluster examines how the development of green finance is linked to sustainable economic growth, with a particular focus on emerging and developing economies. Within this research, green finance is typically viewed as a long-term driver of growth that helps reorient economies away from short-term profit maximisation toward more comprehensive and sustainable development paths. Most studies adopt a macro-level perspective and use indicators such as the Green Finance Development Index alongside econometric techniques, including dynamic panel GMM and spatial econometric models, to assess the effects of green financial policies on GDP, environmental performance and regional development (Lin & Zhao, 2022; Xu et al., 2021). The evidence suggests that green finance generates not only positive effects at the local level but also beneficial spatial spillovers to neighbouring regions. At the same time, the overall effectiveness of green finance is shown to depend strongly on institutional quality, the structure of the real economy and the coordinating capacity of governments, which in turn places high demands on policy design and institutional alignment if the green transition is to be both effective and sustainable.

Brown cluster: Institutional quality, green investment, and environmental performance

Studies in this cluster examine how institutional quality, green investment and environmental performance are interconnected. The empirical evidence suggests that high institutional quality, reflected in political stability, financial transparency and strong governance capacity, is a fundamental condition for enhancing the effectiveness of green investment and attracting international capital flows, while institutional risks and corruption tend to undermine these positive effects in developing countries. To capture these relationships, many studies use techniques such as Stochastic Frontier Analysis (SFA) and Data Envelopment Analysis (DEA) to measure technical efficiency and environmental performance, and at the same time highlight the mediating role of green innovation and technology transfer in turning green investment into actual emission reductions. Taken together, this cluster helps clarify how institutional arrangements and technological innovation jointly shape the design and implementation of effective green investment policies.

3.2.2. Keyword co-occurrence analysis

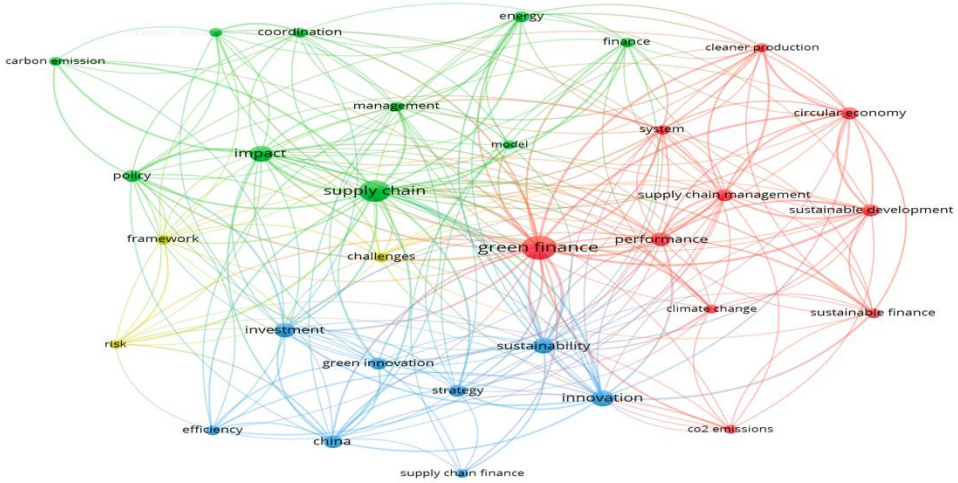

FIGURE 4 - KEYWORD CO-OCCURRENCE ANALYSIS DIAGRAM.

After completing the bibliographic coupling analysis, the study moves on to a keyword co- occurrence analysis. The visual map shows that the keywords “green finance” and “supply chain” co-occurrence with a range of other keywords across the different clusters, specifically (figure 4):

Red Cluster (Green finance & Sustainable development)

The red cluster forms the core of the research network, reflecting the trend toward integrating green finance, sustainable development, and supply chain management. The prominence of keywords such as green finance,

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sustainable finance, circular economy, supply chain management, performance, climate change and sustainable development points to a strong connection between green capital and environmental as well as social performance in logistics and production activities. What stands out in this cluster is the convergence of three core pillars: finance, the environment and the supply chain. Together, these pillars provide a solid theoretical basis for designing integrated green finance models within green supply chain management. This represents a highly applicable research direction for countries pursuing green transition and comprehensive sustainable development.

Green Cluster (Supply chain, policy, and governance)

The green cluster highlights the depth of policy frameworks and the regulatory role of the state in advancing green finance and green supply chains. The prominence of keywords such as policy, governance, management, coordination, energy, carbon emission, and modelling indicates growing interest in regulatory instruments and multi stakeholder coordination across supply chains. Studies in this cluster mainly assess how policy instruments such as green credit, carbon taxes and ESG standards contribute to improving operational performance and cutting greenhouse gas emissions. A striking feature is the shift from a focus on "intra-firm governance" to "system-level supply chain governance," where financial decisions and public policies are jointly designed to achieve sustainable development goals across the entire chain. This cluster plays an important role in establishing the theoretical foundation for models of state–business collaboration aimed at effectively channeling green capital and allocating environmental responsibility throughout the value chain.

Blue Cluster (Innovation/Green innovation, & China/Investment)

The blue cluster clearly reflects the technological and innovation-driven trend in green finance, focusing on the role of innovation as an intermediary that enhances the effectiveness of green finance in supply chain management. Prominent keywords include innovation, green innovation, sustainability, investment, strategy, efficiency, and China. Many studies indicate that green investment not only strengthens competitive advantage but also makes supply chains more resilient, especially when new technologies such as blockchain, big data, and IoT are applied to track financial flows, material flows, and emissions. Taken together, this cluster helps to establish an important basis for strategies that embed technological innovation into green investment, thereby supporting the broader goal of comprehensive sustainable development.

Yellow Cluster (Risk & Framework/Challenges)

The yellow cluster is relatively small in scale but carries high academic value, focusing on risk management in green finance and supply chains. The studies develop integrated risk management frameworks that combine quantitative factors (ESG indicators, emission coefficients) and qualitative factors (organizational commitment, awareness) to identify the challenges in implementing green finance. This cluster opens a new research direction on firms' green risk management capability.

Overall, the keyword clusters depict a multi layered thematic structure in which green finance is conceptually connected with policy, innovation, performance, and risk, suggesting several directions for future empirical studies across different sectors. This indicates that green finance is not only an investment instrument but also an integrated strategy linking policy, technology, and supply chain performance, thereby providing the foundation for multivariate models that assess resilience and sustainable development performance across sectors such as logistics, tourism, and manufacturing.

4. DISCUSSIONS

The bibliometric analysis suggests that research on green finance and supply chains is gradually converging into a multi-layered knowledge framework structured around six interconnected pillars: green finance, green supply chains, policy and institutions, innovation, risk management and sustainable performance. It should be noted that the eight bibliographic coupling clusters should not be interpreted as fully isolated or mutually exclusive research streams. Rather, they represent algorithmically generated research fronts based on shared reference patterns among publications. Given the relatively small size of the dataset and the emerging nature of the field, some degree of conceptual overlap among clusters is expected. For example, ESG integration and

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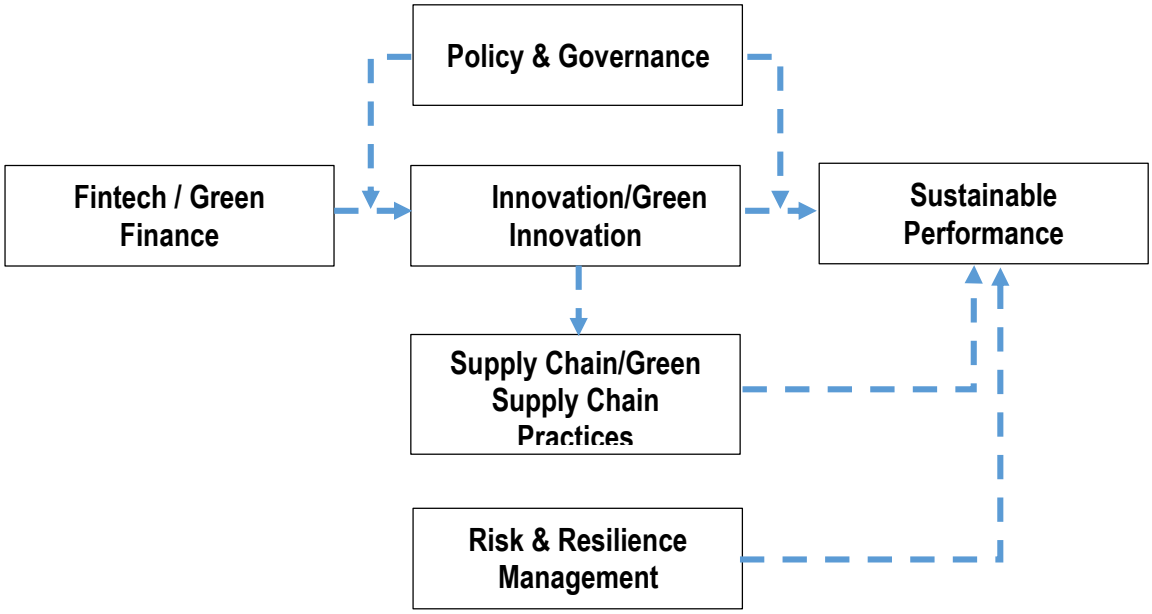
institutional quality are closely related to green investment governance, while sustainable economic growth and green economic growth share a common concern with development outcomes. Similarly, circular economy and technological innovation are frequently connected through discussions of green innovation and resource efficiency. Therefore, this study interprets the eight clusters as fine-grained thematic groupings and further synthesizes them into broader conceptual pillars in the discussion and proposed framework.

These pillars are closely intertwined, signalling a shift away from purely descriptive approaches toward more systemic and interdisciplinary integrated models. Results from the keyword co-occurrence analysis further show that green finance occupies a central position, linking major themes such as supply chain, sustainability, innovation and policy, which indicates that green finance should be understood not only as a funding instrument but also as a strategic coordination mechanism that aligns investment, technology and sustainable supply chain management.

Although green finance and green supply chain management are generally presented in the literature as important mechanisms for advancing sustainability, their implementation is not free from limitations and tensions. First, greenwashing may occur when firms use green labels, ESG disclosures, or sustainability claims without making substantive operational changes. Second, efficiency improvements generated by green technologies may produce rebound effects if lower costs or higher productivity lead to increased production and consumption. Third, the benefits of green finance may be unevenly distributed, as large firms often have better access to green credit, ESG reporting systems and compliance capabilities than small and medium-sized enterprises. Finally, firms may face tensions between financial returns and environmental outcomes, particularly when short-term profitability conflicts with long-term sustainability investment. Recognising these issues is important for developing a more balanced research agenda and for designing green finance mechanisms that are credible, inclusive and environmentally effective.

The research map also points to strong diffusion from countries such as China, India and several European economies, where green finance has begun to be embedded in policy frameworks and industrial systems. By contrast, a noticeable gap remains in developing economies such as Vietnam, where empirical data are still limited but the potential to apply green finance in sectors like logistics, tourism and renewable energy is substantial. This gap opens up important opportunities for future studies to design models that are better tailored to specific national and local contexts (Figure 5).



Note: Arrows indicate conceptual linkages derived from thematic structures in the bibliometric analysis, rather than causal relationships.

FIGURE 5- CONCEPTUAL FRAMEWORK DERIVED FROM BIBLIOMETRIC THEMATIC STRUCTURES

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Proposed conceptual pathway: "Fintech / Green Finance → Innovation / Green Innovation → Supply Chain / Green Supply Chain Practices → Sustainable Performance".

Contextual axis (upper): Policy and governance is positioned as a contextual pillar that is conceptually linked to the relationships among green finance, innovation, and sustainable performance in the mapped literature. It highlights how regulatory frameworks and institutional settings are frequently discussed alongside these themes.

Lower pathway (risk and resilience dimension): Risk & Resilience Management shows a strong thematic linkage with Sustainable Performance within the mapped literature.

In summary, the bibliometric analysis indicates that research on green finance and supply chains is gradually converging into a multi-layered knowledge framework in which six core elements, namely green finance, sustainable supply chains, policy and institutions, innovation, risk management and sustainable performance, are closely interlinked. Within this structure, green finance occupies a central position by connecting key pillars such as investment, innovation and supply chain performance. This emerging knowledge architecture marks a shift from descriptive approaches toward integrated systems thinking and shows strong potential for application in sectors such as logistics, tourism and renewable energy. At the same time, it offers a basis for designing comprehensive green finance governance models that are consistent with sustainable development objectives in Vietnam and the wider ASEAN region.

5. CONCLUSIONS

This study provides a bibliometric review of research linking green finance and supply chain management using data retrieved from the Web of Science Core Collection. By applying two complementary techniques, namely bibliographic coupling and keyword co-occurrence analyses, the study maps the field's thematic structures, delineates major research streams, and highlights emerging themes. Overall, the study explicitly addresses and closes the three research questions (RQ1–RQ3). Specifically, bibliographic coupling identifies the main thematic structures and research streams in the literature (RQ1), keyword co-occurrence analysis reveals dominant themes, topical connections, and emerging research directions (RQ2), and the synthesis of these bibliometric insights supports the development of a conceptual framework and a future research agenda for subsequent empirical validation (RQ3).

The findings indicate that current research concentrates on several interconnected thematic areas, including policy and governance mechanisms, green innovation, green supply chain practices, risk and resilience management, and sustainable performance. These themes form a coherent knowledge structure that can support both scholars and practitioners in positioning future work and aligning green finance initiatives with sustainable supply chain strategies. The proposed conceptual framework, derived from the identified thematic structures, offers a structured lens for future empirical studies to examine the relationships suggested by the existing literature.

This study has limitations. First, the analysis relies on a single database and English language records, which may omit relevant studies indexed elsewhere or published in other languages. Second, the dataset was collected in September 2025; therefore, publications appearing in the final quarter of 2025 were not included. Future bibliometric updates may extend the dataset to cover the full year and examine whether the thematic structure remains stable. Third, bibliometric methods reveal patterns of conceptual linkage rather than causal relationships. Future research should therefore extend the dataset using additional databases and employ empirical designs to validate the proposed framework across different contexts and industries.

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