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Mapping the Research Landscape of Green Finance using a Bibliometric Analysis

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ABSTRACT

This study applies bibliometric and textual analysis to examine the growth and thematic orientation of Green Finance research. Citation analysis reveals increasing scholarly interest, with China emerging as the leading contributor in terms of publications, citations, and collaborative strength. Influential works highlight how Green Finance supports renewable energy adoption, technological innovation, and productivity improvements. Key publication platforms include Environmental Science and Pollution Research and Energy Economics, which have become central outlets for advancing the field. Textual analysis identifies six thematic clusters: foundational concepts (green credit, green economy), policy frameworks (SDGs, financing mechanisms), practical applications (innovation zones, reforms), methodological approaches (natural experiments, high-quality development), technological transitions (low-carbon economy, digitalization), and financial instruments (green bonds, sustainable investment). The recurring focus on carbon emissions, renewable energy investment, and sustainable investment highlights the field's strong alignment with global sustainability priorities. Overall, the findings demonstrate that Green Finance has matured into a multidisciplinary research domain. Future opportunities lie in diversifying regional contributions, expanding methodological approaches, and strengthening cross-disciplinary integration to enhance its role in achieving sustainable development.

Keywords: *Green Finance, Sustainable Development, Carbon Emissions, Green Bond*

1. Introduction

Sustainable green environment is a need of an hour, all economies in the world transitioning towards sustainability, low carbon emission and limit global warming (Paris Agreement). Several multilateral agreements—such as the Paris Climate Accord and the UN Sustainable Development Goals (SDGs)—have reinforced the role of financial markets, institutions, and regulatory bodies in navigating economies towards low-carbon and resilient pathways resulting in growing significance of green finance in recent times.

Green finance is an important instrument that aligns financial system with environmental objectives. Role of finance has been very crucial in aligning this goal as an active enabler of ecological change(Zhou, 2020). Consequently, the academic research in green finance, encompassing diverse themes such as green bonds, renewable energy investment, climate risk, energy transition, green innovation, and sustainable banking have significantly increased (Rasoulinezhad, 2022) (Gu, 2023).

Similarly, (Shen, 2021) explore the interaction between green investments, financial development, and natural resource use in emerging economies, emphasizing on the complexity of green financing decisions in resource allocations

An emerging trend in the field is the integration of environmental health and public health outcomes into financial frameworks. The Lancet report by (Romanello, 2022) in represents this shift by linking green financial systems to planetary health and climate resilience, thereby expanding the boundaries of traditional green financial system.

Despite the expanding literature, systematic understanding of its evolution, dominant themes, influential contributors, and geographic patterns remains

fragmented. This gap motivates the need for a comprehensive bibliometric analysis of green finance literature. Bibliometric methods, by leveraging quantitative tools such as citation analysis, co-authorship networks, and keyword co-occurrence, to provide a robust framework to map the intellectual structure and emerging trends in a research domain. Such an approach is particularly valuable in green finance, where interdisciplinary linkages span environmental economics, finance, energy studies, and public policy.

Bibliometric analysis helps in consolidating the fragmented literature in a systematic manner to guide future research. For instance, a study by (Zhou X. T., 2020) emphasizes how green finance contributes to both environmental and economic development in China, indicating the dual role of financial systems in ecological and growth outcomes.

Moreover, the energy transition literature has increasingly linked green finance to efficiency gains and low-carbon innovations. (Rasoulinezhad, 2022) argue that targeted green financing strategies can significantly improve energy efficiency, thereby reducing emissions intensity in production sectors. (Tian, 2022) assess how post-pandemic fiscal recovery packages can be strategically aligned with global decarbonization goals through green finance, particularly by investing in renewable infrastructure.

In addition, green bonds—debt instruments specifically earmarked to fund environmentally beneficial projects—have gained traction in both developed and developing markets. The study by (Arif, 2021) on dynamic spill over effects between green bonds, renewable energy, and commodity prices sheds light on the interconnected nature of environmental and financial markets. This evolving nexus has implications for risk management, asset pricing, and portfolio diversification strategies in green finance.

Another vital strand of the literature relates to the role of institutional innovation in facilitating green transformation (Xu, 2025) investigate the link between green innovation, financial performance, and the adoption of green financing instruments by firms. Their findings reveal that institutional mechanisms, such as ESG reporting standards and green credit policies, are central in incentivizing firms to align their operations with sustainable development goals.

These diverse perspectives emphasize that green finance is a complex, multifaceted domain influenced by economic, political, technological, and environmental factors. A bibliometric approach allows for the mapping of these interdependencies and the identification of knowledge clusters, research gaps, and emerging thought leaders in the field.

Additionally, geographic distribution and institutional collaboration patterns play a significant role in shaping the green finance landscape. As (Shen, 2021) and (Zhou X. T., 2020) highlight, China has emerged as a major contributor to green finance research and practice, reflecting its national policy priorities and regulatory support for green development. Other economies, such as the European Union, the United States, and select Asian and African nations, are also increasingly embedding green finance into their regulatory and economic frameworks.

Despite this momentum, challenges persist. The lack of standardized definitions, inconsistent measurement frameworks, and insufficient cross-border coordination continue to hamper the scalability of green finance. Moreover, the risk of greenwashing—where firms falsely claim environmental credentials—threatens the credibility of green financial instruments. These concerns underscore the importance of robust academic scrutiny and the development of evidence-based standards, which bibliometric studies can support.

In light of these developments, this paper undertakes a comprehensive bibliometric analysis of green finance literature using a curated dataset of peer-reviewed publications spanning the past two decades. By analysing publication trends, citation metrics, co-authorship networks, keyword co-occurrence, and thematic evolution, the study seeks to answer the following key questions:

- What are the temporal and spatial trends in green finance research?
- Which authors, institutions, and countries are the most influential in this domain?
- What are the dominant and emerging themes in the green finance literature?
- Where are the gaps, and what directions does future research need to pursue?

This analysis contributes to the existing body of literature by offering a meta-perspective on green finance research. It not only consolidates fragmented insights but also sets the stage for interdisciplinary collaborations and informed policy interventions. As financial systems increasingly face the dual pressure of profitability and sustainability, understanding the knowledge architecture of green finance becomes both timely and necessary. In summary, the study builds upon the foundational work of influential scholars such as (Zhou X. T., 2020), (Shen, 2021)(Rasoulinezhad, 2022) and (Romanello, 2022) among others, and extends it through a quantitative bibliometric lens. It is hoped that the insights generated will serve as a valuable resource for academics, practitioners, and policymakers committed to advancing sustainable finance.

2. Literature review

2.1 The theoretical foundation

Foundational Phase: Conceptualization and Policy Alignment (2016–2019)

The earliest GF literature aims to define what "green" means in finance, typically via conceptual frameworks or policy narrative. Pioneering work by Wang & Zhi (2016) highlighted alignment gaps between market mechanisms and policy incentives, urging the need for coordinated strategies. Taghizadeh-Hesary & Yoshino (2019) advanced this discourse by analytically laying out channels for private capital mobilization, such as credit guarantees and tax-revenue recycling—yet noted a lack of empirical testing. Bibliometric analyses in this era (Zhang et al., 2019; Feng, Y. et al., 2019) established the fragmented and fast-accelerating character of GF research post-Paris Agreement. The paper by Kaur and

Negi (2025) presents a systematic literature review and bibliometric analysis focused on inclusive green finance, emphasizing the role of the digital economy and green growth. It synthesizes existing research to identify key themes, trends, and gaps in the intersection of green finance and digital technologies. The study highlights how digital innovations facilitate sustainable financial practices that promote environmental goals while fostering economic growth. It also discusses policy implications and future research directions to enhance the integration of inclusive green finance within the evolving digital economy framework, aiming to support sustainable development. The paper by Kozar and Wodnicka (2024) conducts a bibliometric analysis exploring the intersection of FinTech and green finance. It systematically examines research trends, authorship patterns, and thematic focuses within this emerging field. The study identifies how financial technologies contribute to sustainable finance by enhancing transparency, efficiency, and accessibility in green investments. It also highlights the growing academic interest and evolving research directions that integrate technological innovation with environmental finance. The paper provides insights into key contributors and collaboration networks, offering a comprehensive overview of the current state and future potential of FinTech-driven green finance.

Empirical Shift: Policy, Impact, and Models (2020–2023)

Empirical methods took center stage as researchers assessed China's policy experiments, notably the Green Credit Policy (GCP). Using econometric and quasi-experimental techniques, Zhou et al. (2020), Ren et al. (2020), and Zhang, D. et al. (2020) showed that GF policies can reduce pollution, increase investment in renewables, and foster green innovation—albeit facing regional disparities and proxy measurement challenges. Expansion to OECD and BRICS (Xu, L. et al., 2020; Khan, S.A.R. et al., 2021) diversifies the empirical palette, while Meo & Karim (2022) confirm robust emissions reductions in leading GF economies. The literature also routinely turns to the Environmental Kuznets Curve (EKC) to interpret the financial-environmental dynamic.

Recent Maturation: Digitalization, Markets, and Inclusion (2021–2023)

Thematic scope has shifted to integrate digital finance, green bonds, fintech, and ESG investing. Flammer (2021) and Li, Z. et al. (2023) empirically link green bonds with improved corporate environmental performance, but also point to nascent market size and corporate-skewed issuance. Lee, Chi-Chuan et al. (2022), Yu et al. (2021), and others show that green finance lifts innovation and green productivity across sectors, with digital and fintech channels emerging as powerful—yet unevenly distributed—amplifiers.

Thematic Synthesis: Channels, Instruments, and Evidence

Green finance research has systematically explored several interlinked themes, revealing a comprehensive yet nuanced understanding of how financial mechanisms drive environmental and economic outcomes.

At the conceptual and policy level, early works such as Wang and Zhi (2016) laid a foundation by analyzing the alignment—or misalignment—between market mechanisms and environmental objectives, particularly within renewable energy finance. They highlighted significant policy gaps that constrained the effectiveness of early green finance initiatives. Building on this, Taghizadeh-Hesary and Yoshino (2019) conceptualized innovative financial mobilization models including credit guarantees, tax-revenue recycling, and distributed ledger technologies (DLT). Despite the attractiveness of these models, they underscored a critical lack of empirical validation and practical implementation pathways, leaving an important avenue open for subsequent empirical research to fill.

In response, a wave of empirical studies emerged, concentrating heavily on China's Green Credit Policy (GCP). Zhou et al. (2020), Ren et al. (2020), and Zhang, D. et al. (2020) jointly demonstrated through panel data models and difference-in-difference techniques that GF policies significantly reduce pollution levels and stimulate investments in renewable energy. Yet, they simultaneously noted regional disparities in policy impact and methodological limitations given reliance on proxy indicators for GF.

Complementing these studies, Xu, L. et al. (2020) and Khan, S.A.R. et al. (2021) extended the geographic lens by evidencing positive GF impacts on renewable energy investments in OECD and BRICS countries, thus broadening the empirical base beyond China. Meo and Karim (2022) further reinforced these findings by showing consistent CO2 emission reductions associated with green finance in the world's top green finance economies.

Another prominent research stream examines GF as a driver of innovation and productivity. Yu et al. (2021), Lee, Chi-Chuan et al. (2022), and Jiakui et al. (2023) consistently find that green finance alleviates financing constraints, fostering increased green innovation and improvements in Green Total Factor Productivity (GTFP). This link between finance and innovation further supports structural economic transformation, as highlighted by Wang and Wang (2021), who found tertiary industry sectors benefited the most. The advent of fintech has been shown to amplify these effects, but often unevenly, with advanced, state-owned enterprises gaining more than smaller firms or less developed regions (Lv, Z. et al., 2021; Zhou et al., 2022; Yang et al., 2021).

The evolution of financial instruments forms another critical theme. Flammer (2021) and Li, Z. et al. (2023) illustrate how corporate green bonds serve as effective tools to enhance firms' environmental performance and channel capital toward renewable energy projects. Nonetheless, these authors caution that the green bond market remains nascent, small in size, and heavily focused on corporates rather than sovereign issuers. This limitation emphasizes the need for policy and market innovation to broaden the scope and impact of green financial instruments.

Institutional frameworks and investor behavior also play a vital role in shaping the green finance landscape. Baker et al. (2021) demonstrate rising institutional investor interest in ESG and green financial products, although investor behavior exhibits a preference towards large-scale, lower-risk investments, which can exacerbate funding inequalities. Zhou, X. et al. (2020) provide empirical evidence from China that such policy-driven green finance initiatives can widen regional disparities, with affluent areas disproportionately benefiting. This highlights the ongoing challenge of ensuring equitable access and inclusion within the green finance ecosystem. Finally, bibliometric and review studies such as Zhang et al. (2019) and Feng, Y. et al. (2019) provide a meta-perspective on the field's rapid expansion while exposing fragmented definitions and uneven global attention across regions and topics. These insights establish a crucial foundation, stressing the importance of standardizing terminology and methodologies to unify future GF research.

Collectively, these studies illustrate a landscape in which green finance has demonstrated measurable environmental and innovation benefits through diverse channels and instruments, yet simultaneously faces challenges of geographic concentration, definitional ambiguity, uneven market development, and inclusion. These interconnected themes continue to shape the research agenda and policy discourse in green finance.

2.2 Research gap

Despite advancements, green finance research continues to struggle with critical weaknesses:

- Geographic Overconcentration: China remains overrepresented, curbing cross-context generalizability.
- Definitional Inconsistency: No standardized metrics or definitions persist.
- Methodological Shortcomings: Overreliance on proxies and insufficient causal analysis, especially outside of panel-based Chinese studies.
- Digitalization Underexplored: Fintech and digital finance's transformative potential are still only beginning to be systematically assessed.

3. Methodology

This study employed a comprehensive bibliometric analysis to systematically map the intellectual landscape of green finance research, identifying key publications, influential authors, and emerging themes. The dataset for this analysis was meticulously curated from prominent academic databases, ensuring a broad and representative coverage of the relevant literature (Zhang et al., 2019). Specifically, Scopus and Web of Science were queried using a combination of keywords such as "green finance," "sustainable finance," "environmental finance," and "ESG investing" to capture the breadth of the field (Yu et al., 2021) (Wang et al., 2021). This rigorous approach, encompassing both performance and science mapping analyses, enabled an in-depth examination of publication trends, citation patterns, and collaborative networks within green finance research (Tuyon et al., 2022) (Chàfer et al., 2020) (Zhang et al., 2019). This methodology is particularly effective for identifying the intellectual structure, evolution, and future directions of a rapidly evolving field like green finance, drawing insights from publication characteristics, authorship patterns, and citation impacts (Fahim & Mahadi, 2022). The subsequent analysis delved into co-authorship networks, co-citation patterns, and keyword co-occurrence to unveil the underlying thematic clusters and interdisciplinary connections that characterize green finance scholarship. The bibliometric analysis also facilitates the identification of highly cited works and influential authors, providing a quantitative measure of their impact on the field's development (Kwong et al., 2023). This comprehensive methodological framework allowed for a nuanced understanding of the academic discourse surrounding green finance, revealing both its established pillars and nascent frontiers.

4. Results

4.1 Citation analysis

There is growing interest among academic community towards Green Finance. Green Finance helps to achieve Sustainable Development Goals. A number of Journals are publishing in the field of Green Finance and Sustainability. Table 1 shows the top cited research papers published on Green Finance. The title "How does green finance affect green total factor productivity? Evidence from China" published by Energy Economics in the year 2022 was the highest cited paper followed by research on demand for green finance: Resolving financing constraints on green innovation in China published by Energy Policy. Both these papers were published by authors from China. The way to induce private participation in green finance and investment published by authors in Japan in Finance Research Letters also has good number of citations.

Table 1. Top Cited documents on Green Finance

Title	Source title/Anthology title	Publication Year	Authors	Authors Affiliations - Name of Research organization	Times Cited
How does green finance affect green total factor productivity? Evidence from China	Energy Economics	2022	Lee, Chi-Chuan; Lee, Chien-Chiang	Nanchang University; Southwestern University of Finance and Economics	897
Demand for green finance: Resolving financing constraints on green innovation in China	Energy Policy	2021	Yu, Chin-Hsien; Wu, Xiuqin; Zhang, Dayong; Chen, Shi; Zhao, Jinsong	Southwestern University of Finance and Economics	887

The way to induce private participation in green finance and investment	Finance Research Letters	2019	Taghizadeh-Hesary, Farhad; Yoshino, Naoyuki	Asian Development Bank Institute; Keio University; Waseda University	609
Influence mechanism between green finance and green innovation: Exploring regional policy intervention effects in China	Technological Forecasting and Social Change	2022	Irfan, Muhammad; Razzaq, Asif; Sharif, Arshian; Yang, Xiaodong	Beijing Institute of Technology; Dalian University of Technology; ILMA University; Sunway University; Superior University; Xinjiang University	594
A bibliometric analysis on green finance: Current status, development, and future directions	Finance Research Letters	2019	Zhang, Dayong; Zhang, Zhiwei; Managi, Shunsuke	Kyushu University; Southwestern University of Finance and Economics	541
Impact of green finance on economic development and environmental quality: a study based on provincial panel data from China	Environmental Science and Pollution Research	2020	Zhou, Xiaoguang; Tang, Xinmeng; Zhang, Rui	University of Science and Technology Beijing	535
The Role of Green Finance in Environmental Protection: Two Aspects of Market Mechanism and Policies	Energy Procedia	2016	Wang, Yao; Zhi, Qiang	Central University of Finance and Economics	525
Fostering green development with green finance: An empirical study on the environmental effect of green credit policy in China	Journal of Environmental Management	2021	Zhang, Shengling; Wu, Zihao; Wang, Yao; Hao, Yu	Beijing Institute of Technology; Beijing Normal University	507
Role of green finance in improving energy efficiency and renewable energy development	Energy Efficiency	2022	Rasoulinezhad, Ehsan; Taghizadeh-Hesary, Farhad	Tokai University; University of Tehran	503

Following is the comparative table of above cited research published in " Green Finance " with details on focus, methodology, key findings and policy implications.

Paper	**Focus**	**Methodology**	**Key Findings**	**Policy Implications**
How does green finance affect green total factor productivity? Evidence from China (Lee & Lee, 2022)	Impact of green finance on green total factor productivity (GTFP) in China	Regional-level econometric analysis	Green finance significantly improves GTFP; stronger in developed regions	Expand green finance mechanisms to support industrial upgrading
Demand for green finance: Resolving financing constraints on green innovation in China (Yu et al., 2021)	How green finance mitigates financing constraints for green innovation	Firm-level empirical study	Reduces financing barriers; demand higher in energy-intensive sectors	Strengthen green credit policies to ease financing for green firms
The way to induce private participation in green finance and investment (Taghizadeh-Hesary & Yoshino, 2019)	Mechanisms to attract private sector participation in green finance	Policy and theoretical framework analysis	Risk-sharing, PPPs, and incentives needed to mobilize private capital	Develop frameworks to reduce risks for private investors
Influence mechanism between green finance and green innovation: Exploring regional policy intervention effects in China (Irfan et al., 2022)	Regional policy effects on green finance–innovation relationship	Empirical analysis with regional heterogeneity	Government intervention strengthens green finance's impact on innovation	Adopt region-specific policies to balance green innovation growth
A bibliometric analysis on green finance: Current status, development, and future directions (Zhang et al., 2019)	Mapping research trends in green finance	Bibliometric and scientometric techniques	Research expanding rapidly; key themes: green bonds, policy, sustainability	Encourage more empirical research and policy-linked studies
Impact of green finance on economic development and environmental quality: Provincial panel data from China (Zhou et al., 2020)	Effect of green finance on economic development & environmental quality	Provincial panel data econometric analysis	Promotes economic growth while improving environmental quality	Promote balanced provincial-level green finance initiatives

The Role of Green Finance in Environmental Protection: Market Mechanism and Policies (Wang & Zhi, 2016)	Market mechanisms and policies in green finance	Conceptual and policy analysis	Market and policies complement each other for sustainability	Integrate markets and regulations for effective protection
Fostering green development with green finance: Environmental effect of green credit policy in China (Zhang et al., 2021)	Environmental impact of China's green credit policy	Empirical analysis of green credit impacts	Green credit reduces emissions but varies across industries/regions	Refine green credit policy and enhance monitoring mechanisms
Role of green finance in improving energy efficiency and renewable energy development (Rasoulinezhad & Taghizadeh-Hesary, 2022)	Role of green finance in energy efficiency and renewables	Empirical study on renewable and efficiency improvements	Green finance boosts renewables and efficiency, vital for energy transition	Improve global cooperation and financing accessibility

Table 2 and Figure 2 indicates the top 10 cited Documents of authors across the globe out of 2500 cited documents. The noteworthy work of Taghizadeh-hesary, Farhad (2022) discusses how Green Finance combined with renewable energy and technological innovation to reduce carbon emission can counter climate change. Research by Taghizadeh-hesary, Farhad has strong connectivity with 17 documents and 2012 citations. Taghizadeh-hesary, Farhad are most connected in the literary network.as indicated by total link strength. Amongst the most cited work of Lee, Chi-Chuan; Lee, Chien-Chiang (2022) investigates the impact of Green finance on Green Finance total factor Productivity. Sadiq, Muhammad (2022) conducted a study on Green Energy security assessment in Morocco and proposed that green Finance is essential to scale up renewable energy and energy efficient technology. This will reduce dependence on imports.

Table 2 . Top cited documents and authors

Author	Documents	Citations	Total link strength
Taghizadeh-hesary, Farhad	17	2012	85
Lee, Chien-Chiang	12	1746	75
Sadiq, Muhammad	10	787	20
Sharif, Arshian	6	678	27
Tang, Xinmeng	6	675	35
Mohsin, Muhammad	7	673	31
Hao, Yu	6	565	27
Dong, Kangyin	14	506	58
Zhang, Wei	13	291	37
Ma, Xiaoyu	7	288	39

Figure 2. Top cited documents and authors

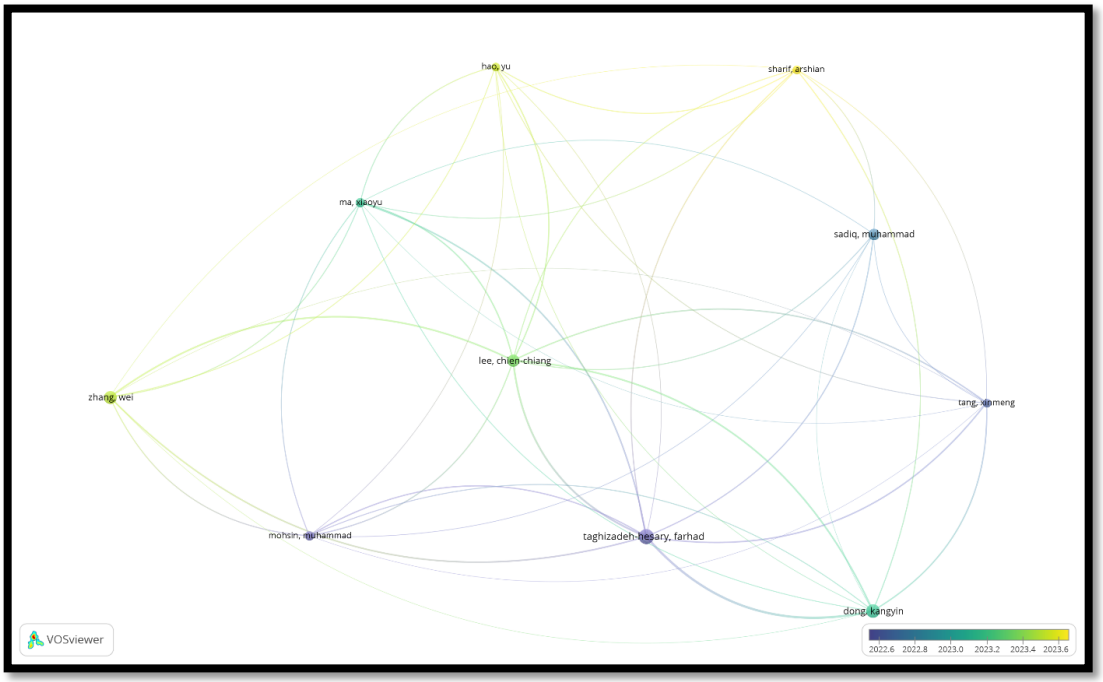


Table 3 and Figure 3 discusses geographical distribution of authors publishing research in the area of Green Finance. China has a strong domination with largest number of publication and citations. China has published 1241 research papers in the area of Green Finance. China is also having largest collaborative strength as can been seen from Total link strength. Pakistan in the 2nd country with 107 publications and 5805 citations. Malaysia has the 3rd largest in terms of publications and citations in the area of Green Finance. The collaborative strength of the authors is also good.

Table 3 . Top cited documents and countries

Country	Documents	Citations	Total link strength
China	1241	37983	6915
Pakistan	107	5805	2129
Malaysia	84	3358	1671
Japan	29	2909	1113
United Kingdom	75	2203	1075
Australia	40	1968	955
Vietnam	36	1658	698
India	69	1607	1022
Lebanon	31	1217	867
Saudi Arabia	41	1019	601

Figure 3. Top cited documents and countries

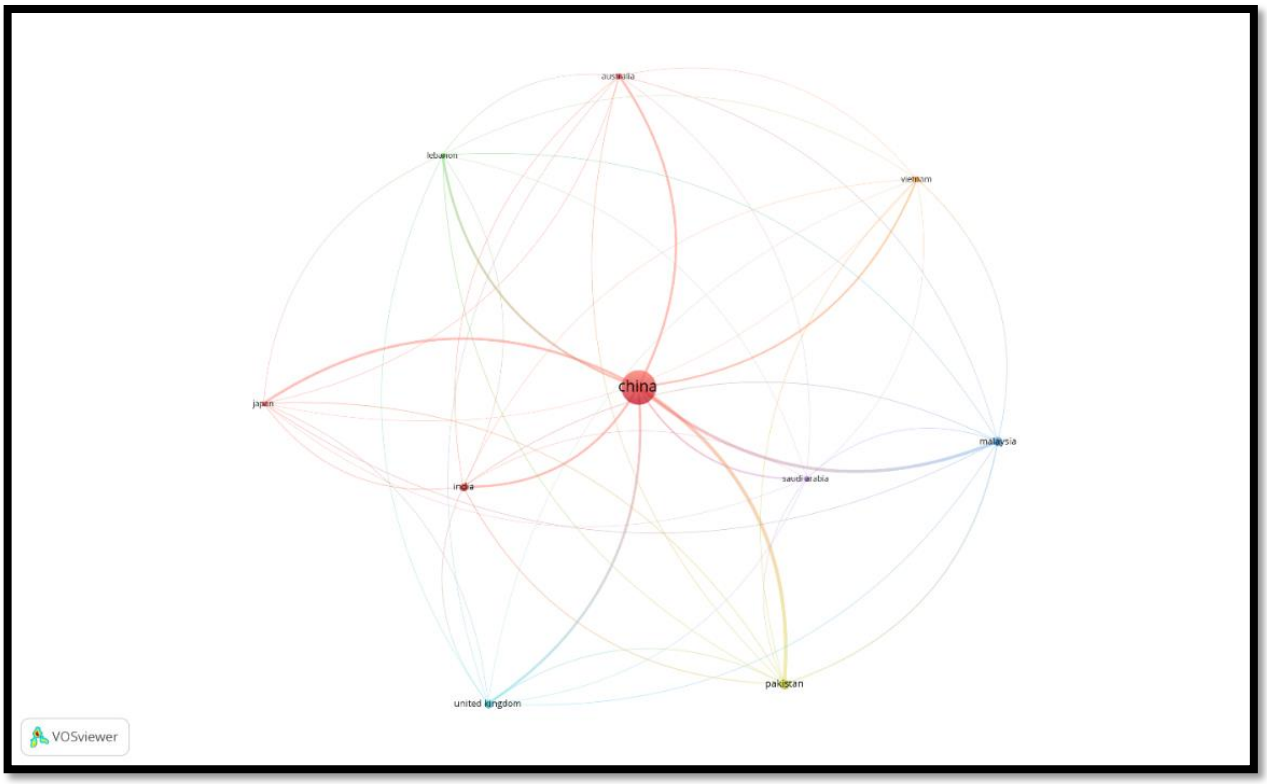


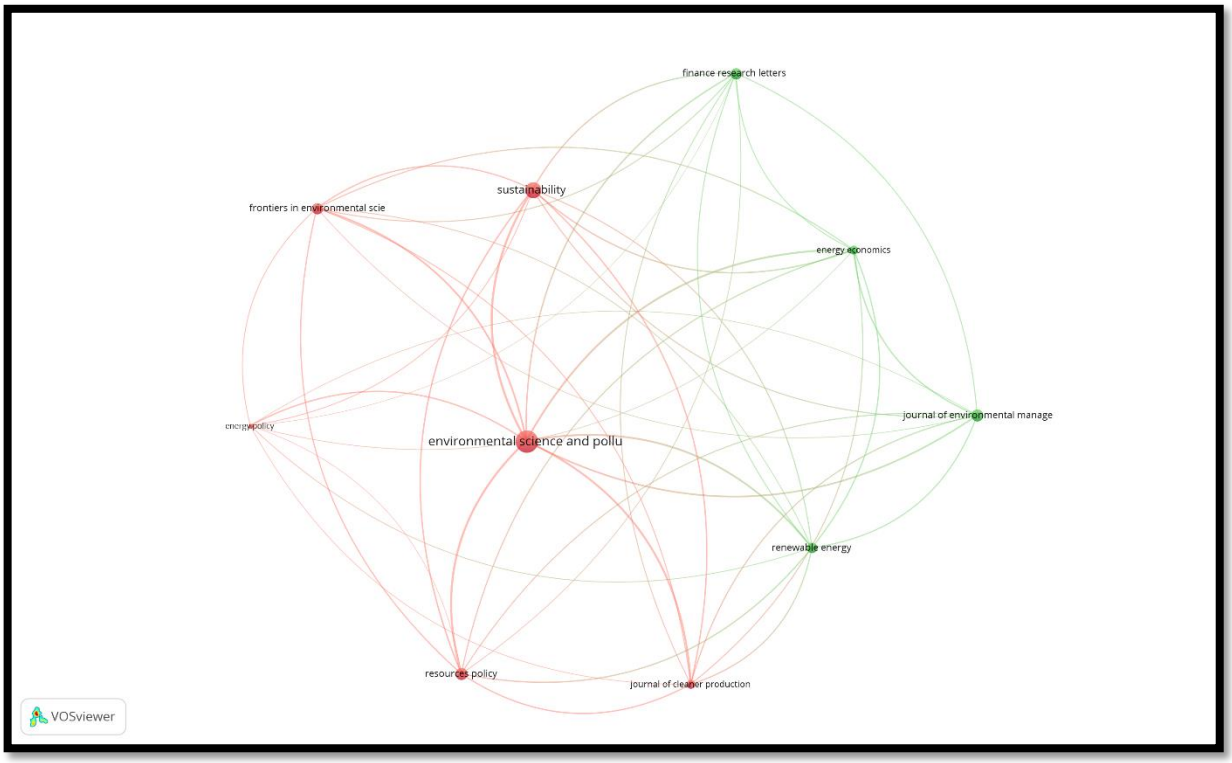
Table 4 and Figure 4 highlights the top journals that publishes most researches on Green Finance. Of the various Journals that published Green Finance, Environment Science and Pollution Research has published maximum number of researches and has maximum number of citations. The link strength also indicates that this journal is most influential and productive. Renewable Energy and Energy Economics also has good number of research publications and citations in the area of Green Finance. The link strength indicates strong network connections.

Table 4 . Top cited documents and Sources

Source	Documents	Citations	Total link strength
Environmental Science and Pollution Research	231	6681	1460
Renewable Energy	50	3824	632
Energy Economics	38	3819	672
Resources Policy	68	3534	740
Journal of Cleaner Production	40	2910	679
Sustainability	121	2451	827

Finance Research Letters	60	2281	461
Journal of Environmental Management	67	2203	562
Energy Policy	12	1615	301
Frontiers in Environmental Science	63	908	566

Figure 4: Top cited documents and Sources



4.2 Text Analysis

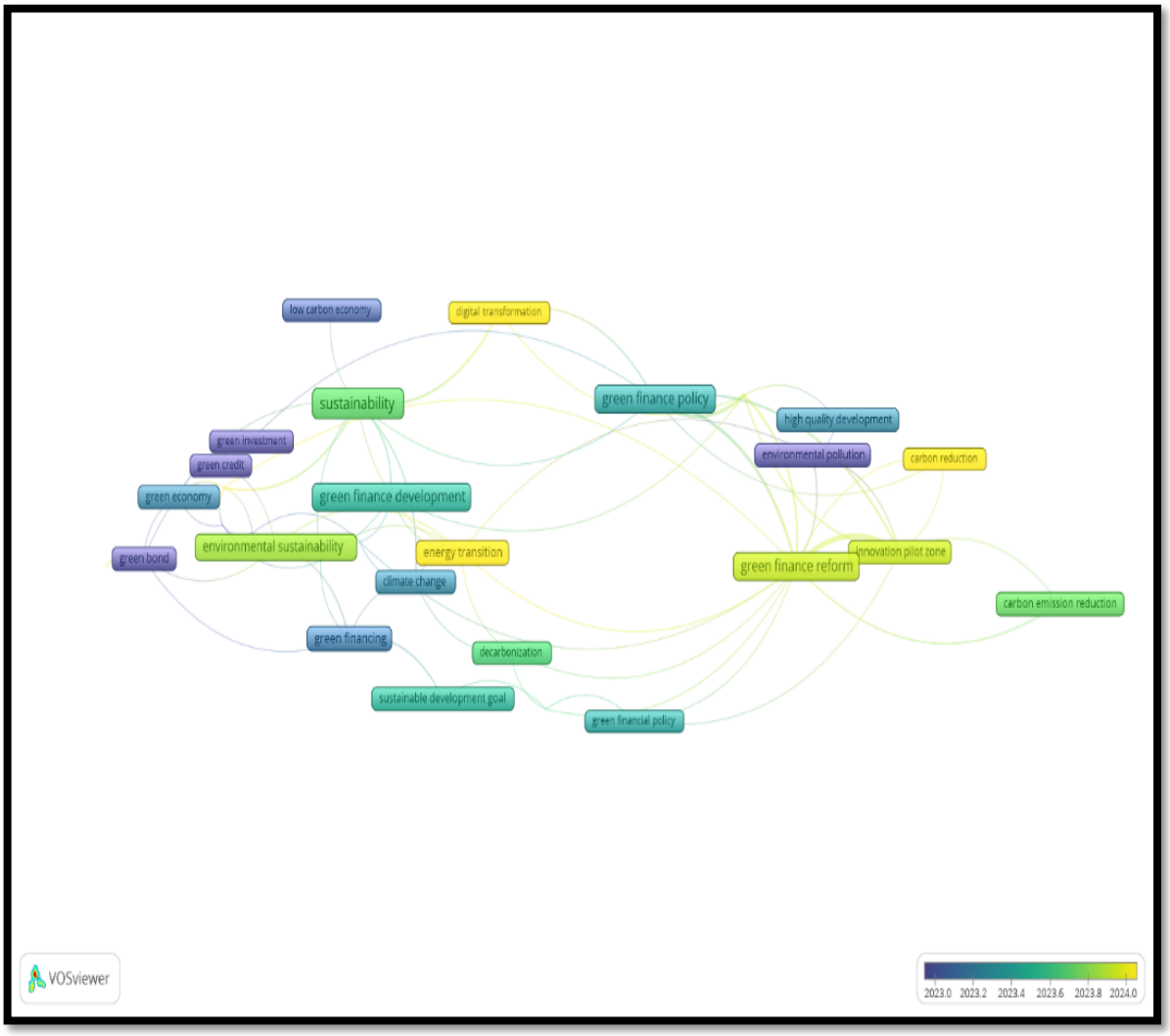
The bibliometric map shows 6 clusters. Each cluster represents a group of related terms that frequently appear together in the same research paper. The key terms extracted from textual analysis is based on the number of times a term appears in the data set and the distinctiveness of the term as indicated by the relevant score. Out of total of 4171 words in titles, when minimum occurrences of words selected as 10, 133 words meets the threshold of 10 occurrences. Of these words 80 words are most relevant 60% of the times. Of these 80 words, words referring to names of countries, regions, nouns like Bibliometric analysis, research, article, nexus, case which were generic in nature are eliminated by the authors. Thus 33 keywords words are selected and top 10 Rank is assigned by the authors to these keywords by sorting the words based on the relevance score from largest to smallest. The term Carbon Emission is the most frequently occurring and highly relevant term in the researches that were analysed. Renewable Energy Investment also has the same relevance score as Carbon Emission followed by the term Sustainable Investment. This analysis reveals a research domain with clear environmental priorities (CO2, renewable energy) supported by diverse financial mechanisms (bonds, credit, investment) within broader economic and policy frameworks, indicating a mature field with both specialized niches and broad application areas.

Table 5: Text analysis with respect to occurrences of title

Term	Occurrences	Relevance score	Rank
Co2 emission	21	4.4806	1
Renewable Energy Investment	15	4.4806	2
Sustainable Investment	10	1.9227	3
Sustainable Development Goal	19	1.5233	4
Green Credit	14	1.3307	5
Green Bond	21	1.3239	6
Low Carbon Economy	13	1.2985	7
Green Economy	18	1.2158	8
Green Financing	35	1.189	9

Green Investment	14	1.11	10

Figure 5. Text analysis with respect to occurrences of title



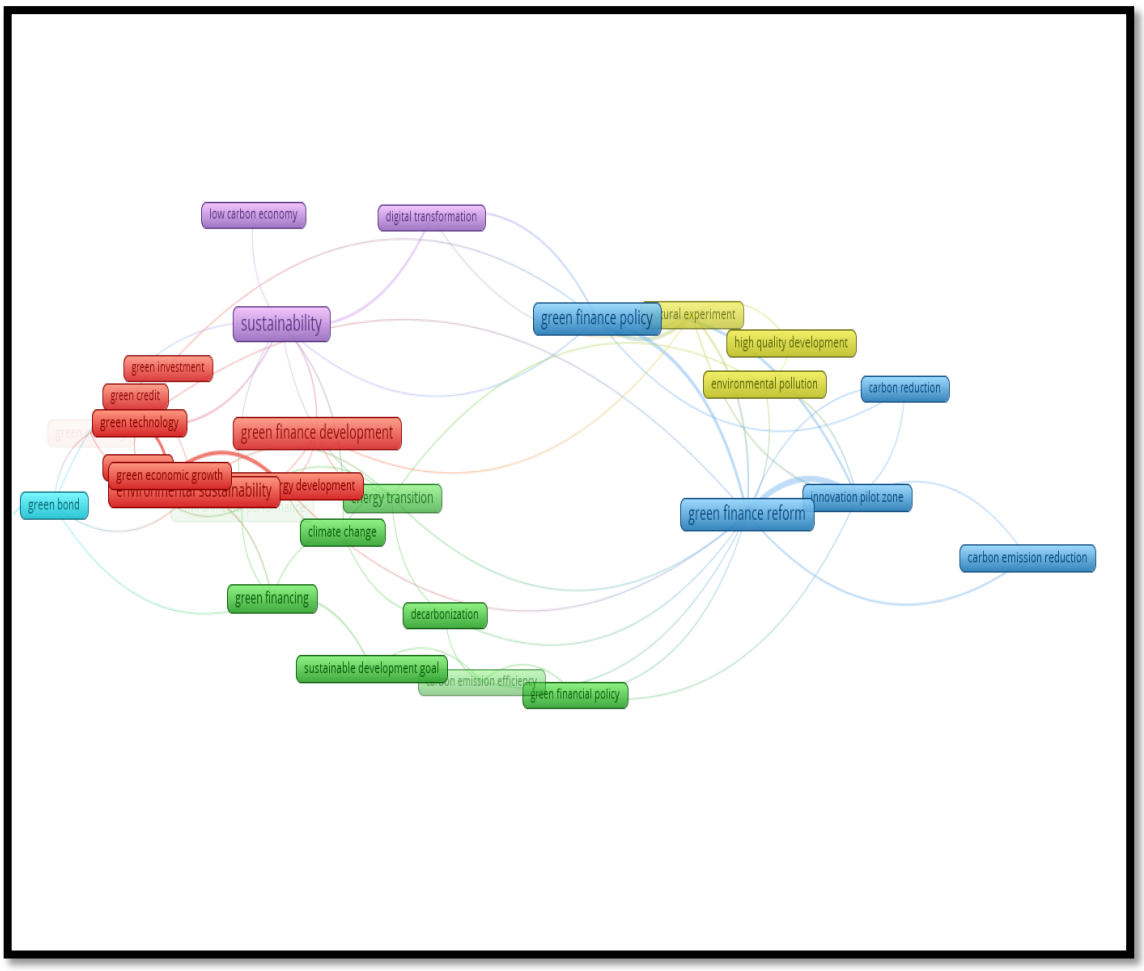
Cluster 1 represents foundational concepts and mechanisms of Green Finance research. Cluster 1 encompasses 9 keywords as listed in table 5. Green Credit emerges as the most distinctive term within this cluster having the highest relevance score of 1.3307 with 14 occurrences. Green Economy with relevance score of 1.2158 but has substantial research volume. This suggests that Green Economy serves as a distinctive theme and frequently explored research area within this domain. Green Finance development shows highest frequency followed by Environmental Sustainability indicating that these two are the most extensively researched topics. However, their relatively lower relevance scores suggest that these terms appear across multiple clusters, making them less distinctive to Cluster 1 ‘s unique identity. The remaining terms Green Investment, Green Energy, Green Economic Growth, Green Technology and Renewable Energy Development demonstrate moderate relevance scores indicating that they are dominant themes within this cluster.

*Table 5 : **Cluster 1***

Term	Occurrences	Relevance Score
Green credit	14	1.3307
Green economy	18	1.2158
Green investment	14	1.11
Green energy	14	1.0503
Green economic growth	15	0.9693
Environmental sustainability	51	0.8729

Green technology	15	0.7298
Renewable energy development	20	0.6637
Green finance development	59	0.5293

Figure 5 .Cluster 1 has 9 key words as shown below



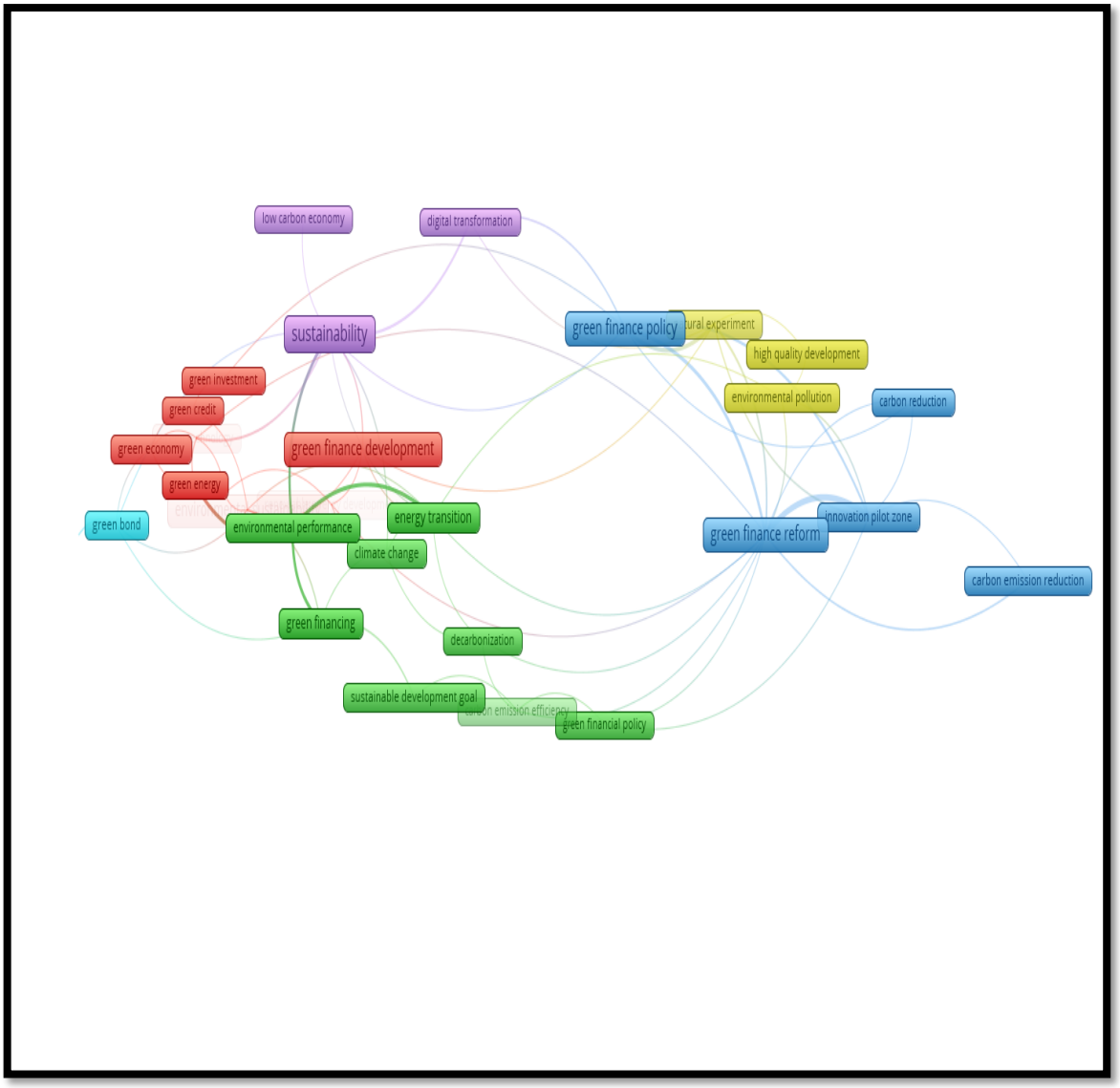
Cluster 2 represents policy implementation and performance evaluation dimension of Green Finance Research with Sustainable Development Goals providing the overarching framework and Green Financing serving as the primary implementation mechanism for achieving measurable environmental performance outcome. Cluster 2 has 8 keywords as listed in table 5. Sustainable Development Goal has highest relevance score of 1.52 indicating that it is the most distinctive term within this cluster. Green Financing with relevance score of 1.18 and has highest number of occurrences suggesting that Green Financing is distinctive research theme and most extensively studied mechanism within this cluster. Environmental Performance has a relevance score of 0.85 with 21 occurrences. This score demonstrates substantial research attention. This cluster also encompasses other terms like carbon emission efficiency , climate change , green financial policy and decarbonisation as effective policy instruments and strategic approaches. Energy Transition has second highest occurrences but lowest relevance score suggesting that this term appears across multiple clusters making it less distinctive to Cluster 2 unique identity.

Table 6: Cluster 2

Term	**Occurrences**	**Relevance score**
Sustainable development goal	19	1.5233
Green financing	35	1.189
Environmental performance	21	0.8567
Carbon emission efficiency	14	0.818

Climate change	16	0.7192
Green financial policy	10	0.6048
Decarbonization	11	0.481
Energy transition	28	0.3054

Figure 6 .Cluster 2 has 8 key words as shown below



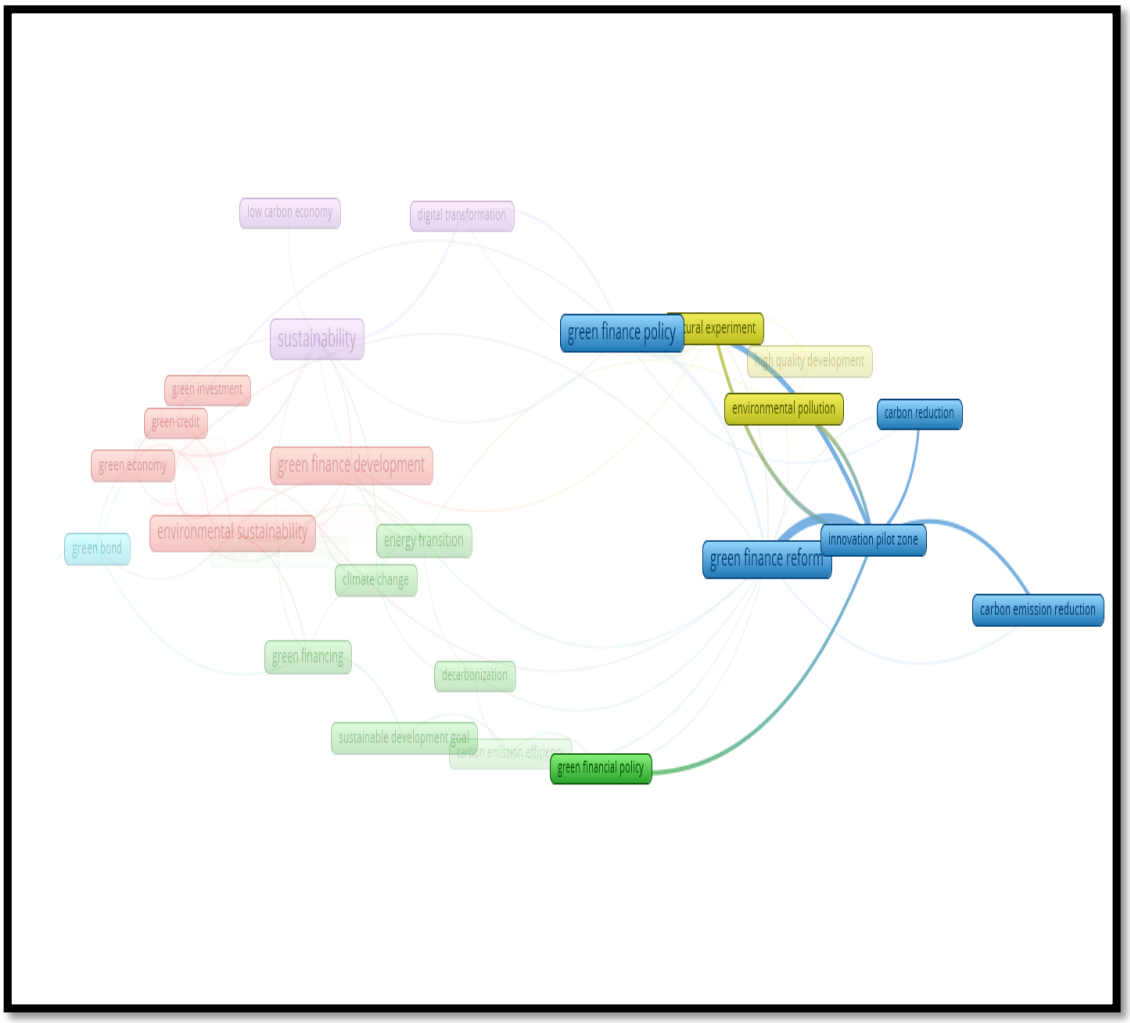
Cluster 3 encompasses key terms that collectively represent practical application of Green Finance Research. This cluster reveals policy practice integration in sustainable finance research. Cluster 3 has 5 keywords as listed in table 7. Carbon Emission Reduction has highest relevance score of 0.4504 thus emerging as the most distinctive term. Carbon Emission reduction emerges as the core outcome objective of this cluster's research focus. Green Finance Policy dominates research volume but shows moderate coherence which means it appears broadly across multiple research themes making it less distinctive to Cluster 3 unique identity. Innovation Pilot zone has highest number of occurrences. Innovation Pilot Zone serves as an important policy implementation mechanism. Green Finance Reform shows substantial research attention with moderate relevance. Carbon Reduction complements the carbon emission reduction theme.

Table 7: Cluster 3

Term	Occurrences	Relevance score
Carbon emission reduction	17	0.4504

Innovation pilot zone	19	0.4175
Carbon reduction	14	0.3887
Green finance reform	62	0.3291
Green finance policy	73	0.3077

Figure 7 .Cluster 3 has 5key words as shown below



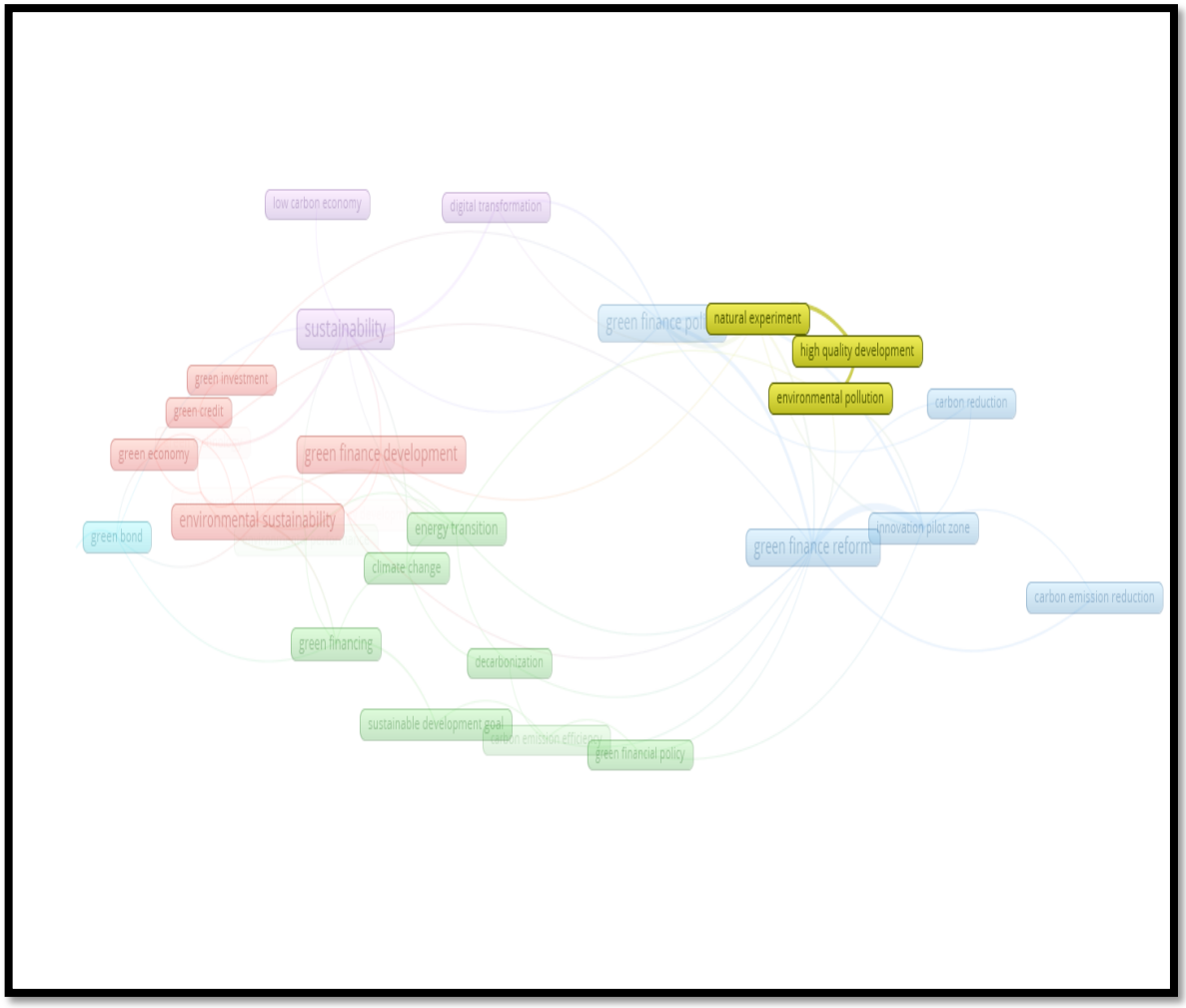
This cluster represents the empirical methodology on green finance research, where natural experimental approaches are employed to evaluate the relationship between high-quality development initiatives and environmental pollution outcomes. The cluster emphasizes rigorous methodological frameworks for measuring the qualitative impacts of sustainable finance interventions on environmental and developmental objectives. Cluster 4 has 3 keywords as listed in table 8 . High quality development emerges as the most distinctive term within this cluster, achieving the highest relevance score of 0.7161 with 20 occurrences. This exceptional relevance indicates that high quality development represents the core conceptual framework that uniquely defines this cluster's research orientation. Natural experiment demonstrates the highest research volume with 23 occurrences while maintaining a moderate relevance score of 0.3644. This substantial occurrence frequency suggests that natural experiments serve as the primary methodological approach within this research domain, providing robust empirical frameworks for evaluating green finance interventions and their environmental impacts. Environmental pollution shows the lowest occurrence frequency (15) but achieves a notable relevance score of 0.3684, positioning it as a key outcome variable of interest. The moderate relevance combined with focused research attention suggests that environmental pollution serves as a critical measurement criterion for assessing the effectiveness of green finance policies and high-quality development initiatives.

Table 8: *Cluster 4 has 3 keywords*

Term	Occurrences	Relevance score

High quality development	20	0.7161
Environmental pollution	15	0.3684
Natural experiment	23	0.3644

Figure 8: *Cluster 4 has 3 key words as shown below*



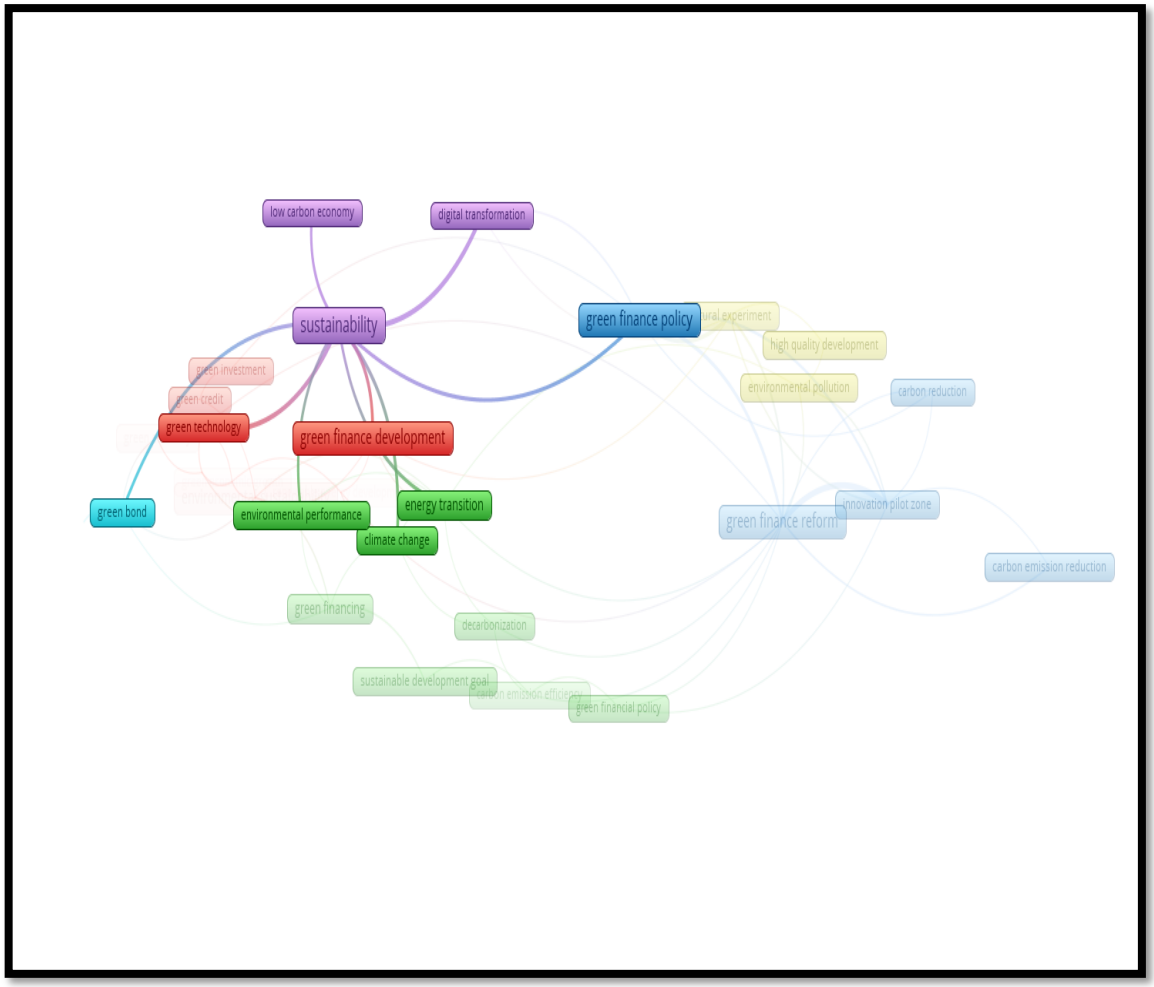
The cluster emphasizes the intersection of technological innovation, economic restructuring, and environmental sustainability, highlighting how digital tools facilitate the transition to low-carbon economic systems.. This cluster demonstrates a focused approach to low-carbon economic transitions facilitated by digital innovation within broader sustainability frameworks. Low carbon economy emerges as the most distinctive term within this cluster, achieving the highest relevance score of 1.2985 with 13 occurrences. This exceptional relevance relative to frequency indicates that low carbon economy represents the core conceptual focus that uniquely defines this cluster's research identity, distinguishing it as a specialized area of investigation within the broader green finance landscape. Sustainability dominates the research volume with the highest occurrence frequency (82) while maintaining a moderate relevance score of 0.6382. This substantial research attention combined with moderate distinctiveness suggests that sustainability serves as the overarching conceptual framework that connects this cluster to broader research themes, providing the foundational context for low-carbon economic transitions. Digital transformation demonstrates focused research interest with 14 occurrences and a relevance score of 0.544, positioning it as a key enabling mechanism within this research domain. The moderate relevance suggests that digital transformation represents an important facilitating factor for achieving low-carbon economic objectives, though it may also appear in other technological or innovation-focused clusters.

Table 9 *: Cluster 5*

Term	Occurrences	Relevance score
Low carbon economy	13	1.2985

Sustainability	82	0.6382
Digital transformation	14	0.544

Figure 9: *Cluster 5 has 3 key words as shown below*

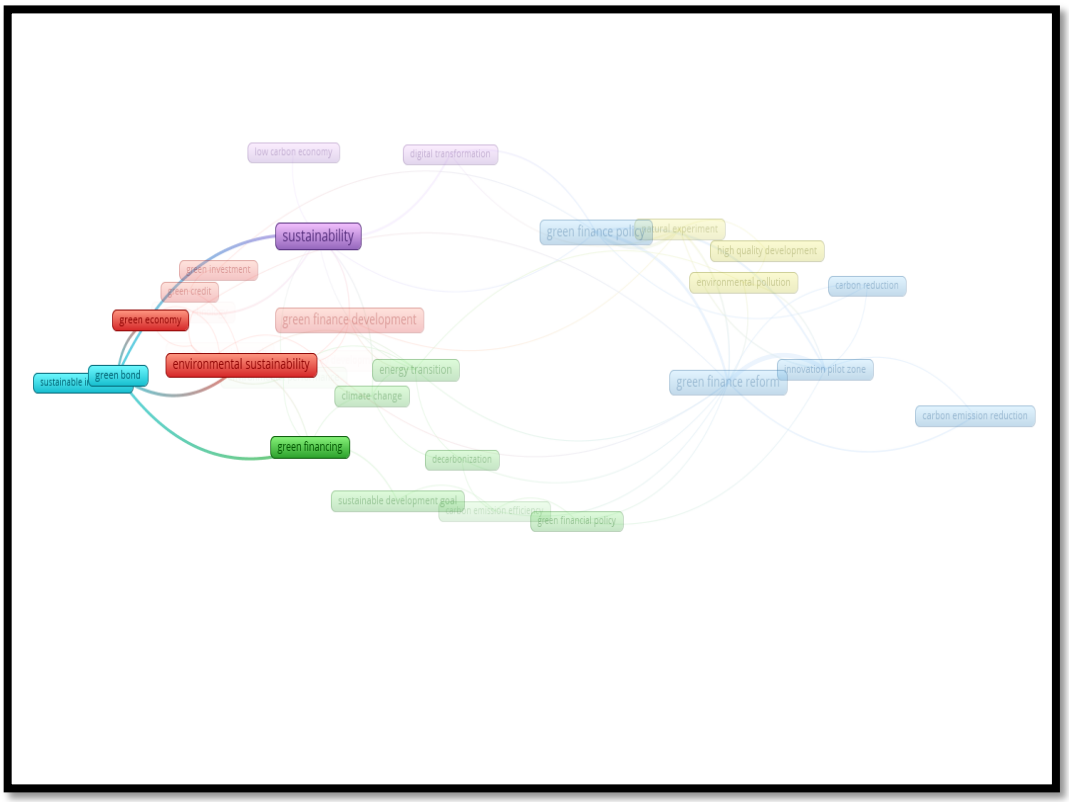


Cluster 6 has This cluster represents how specific financial instruments (green bonds) enable broader sustainable investment approaches. Green Bonds serve as the primary implementation mechanism for sustainable investment strategies. The cluster's exceptionally high relevance scores suggest this represents a highly specialized research area focused on market-based solutions, distinguishing it from policy-oriented or outcome-focused clusters. Cluster 6 comprises 2 key terms that collectively represent the financial instruments and investment mechanisms dimension of green finance research, as presented in Table 10. This cluster demonstrates a highly focused approach to market-based green finance solutions with exceptional thematic distinctiveness. Sustainable investment emerges as the most distinctive term within this cluster, achieving the highest relevance score of 1.9227 with 10 occurrences. This exceptional relevance score—the highest observed across all clusters—indicates that sustainable investment represents a highly specialized and unique research focus that strongly defines this cluster's identity. The high distinctiveness relative to moderate frequency suggests this represents cutting-edge or niche research within the broader green finance domain. Green bonds demonstrate substantial research prominence with the highest occurrence frequency (21) while maintaining a strong relevance score of 1.3239. This combination positions green bonds as both a extensively studied and highly distinctive financial instrument within this research area. The substantial research volume indicates that green bonds serve as a primary mechanism for implementing sustainable investment strategies.

Table 10 *: Cluster 6*

Term	Occurrences	Relevance score
sustainable investment	10	1.9227
green bond	21	1.3239

Figure 10 : *Cluster 6 has 2 key words as shown below*



5. Conclusion, implications and limitations

The bibliometric and text analysis of Green Finance research highlights its rapid evolution as a multidisciplinary field with strong academic and policy relevance. Citation analysis reveals that the most influential contributions originate predominantly from China, which not only leads in terms of publication volume but also demonstrates the highest collaborative strength globally. Renowned scholars, including Taghizadeh-Hesary and Lee, have significantly contributed to the discourse by associating green finance with technological innovation, renewable energy, and productivity enhancements, thereby establishing the intellectual underpinnings of the field. Esteemed journals such as Environmental Science and Pollution Research and Energy Economics serve as the most influential publication platforms, further reinforcing the field's legitimacy.

Textual analysis underscores the thematic depth of Green Finance research. Six distinct clusters emerge, encompassing foundational concepts (green credit, green economy), policy frameworks (SDGs, financing mechanisms, environmental performance), practical applications (policy reform, innovation zones), methodological rigor (natural experiments, high-quality development), technological transformations (low-carbon economy, digitalization), and financial instruments (green bonds, sustainable investment). The prevalence of terms such as carbon emissions, renewable energy investment, and sustainable investment indicates a clear research alignment with pressing global environmental challenges and transition strategies.

Overall, the analysis reveals Green Finance as a mature yet dynamically expanding research domain. It integrates environmental sustainability with financial innovation, policy frameworks, and empirical validation. The field demonstrates both broad application areas—addressing climate change, carbon reduction, and sustainable growth—and specialized niches such as green bonds and digital transformation. This maturity, coupled with regional concentration in Asia (particularly China), suggests strong momentum but also highlights the opportunity for more geographically diversified contributions. Future research endeavors should focus on expanding into underrepresented regions, enhancing methodological innovation, and bolstering cross-disciplinary integration. These efforts will further establish Green Finance as a crucial catalyst for sustainable development.

6. Future Scope for Research

Future studies should focus on cross-country, cross-sector comparison and causal policy impact research. Develop universal definitions and robust measurement tools, extend empirical validation to novel financial mobilization mechanisms and Deepen systematic study of digital and fintech channels for inclusivity and scalability.

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