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Scientific mapping of Green Finance Research: A Bibliometric Perspective

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Abstract

Purpose- Green finance is an essential instrument for combating climate change and a major force behind sustainable economic expansion. Green financing may support sustainable development, encourage innovation, and create green jobs by channelling financial resources towards environmentally conscious initiatives and activities.

Design, methodology, and approach- Using a bibliometric examination of more than 700 publications published between 2000 and 2024, this study investigates the development of green finance. Several important issues are highlighted in the report, including "Green financing," "Green bonds," "fintech," and " green innovation," all of which are crucial for advancing sustainable development and reducing climate change.

Findings- Most relevant articles appear in journals devoted to environmental and sustainability concerns, suggesting that green financing is an integrative discipline that bridges environmental sciences and finance. **Practical Implications**- However, the study recognizes certain limitations, including the potential exclusion of important studies and the reliance on authors' keywords, which may impact the precision of theme identification and clustering.

Originality- A key contribution of this research is the identification and emphasis on crucial sources, prominent authors, and key documents in preparation for the bibliometric paper.

Topics Mentioned- Introduction, Research Methodology, Descriptive Statistics Generation, Keyword Analysis, Thematic Map, Findings, Conclusion & Discussion, Future Research Directions

***Keywords*:** green finance, bibliometric perspective, green innovation, sustainability

Introduction

Green finance has gained prominence recently due to the global agreement on environmental The worldwide agreement on climate change action, environmental preservation, and the 2030 Sustainable Development Goals of the United Nations (SDGs) have all contributed to the rise in popularity of green financing (Widagdo and Amidjaya 2019; Schulz and Dörry 2018). Additional terms for green finance include "climate finance," "sustainable financing," "environmental financing," and "green investment." Green finance reached a crescendo of relevance at the 11th G-20 session in Hangzhou, China in 2016 (Schäfer 2018; Liu et al. 2019), and it was covered and discussed in great detail. Multiple explanations of green finance draw attention to the various facets of the concept that the researcher deems significant, resulting in a range of viewpoints and degrees of interest in the area. The IFC (2009) defined green finance as financial mechanisms that promote economic prosperity, provide social justice, and safeguard the environment. The theory suggests that financial firms' policies promote the green economy, according to Lindenberg (2014). The "finance" aspect of the concept shows how capital and investments are distributed through financial systems (Weber & ElAlfy 2019; Berensmann et al. 2017).

Banks serve as community intermediaries by receiving and distributing idle money to foster economic development (Fu and Ng 2020; Andreeva et al. 2018). Wójcik and Urban (2019) and Gallagher and Yuan (2018) assert that the "green" component of green finance requires financial resources to be distributed among all economic sectors for corporate responsibility, social integration, energy conservation, environmentally conscious construction, mitigating climate change, and environmental protection. The most disheartening aspect of the modern global market is the comparatively low level of investment.

In high-income countries, housing costs and private consumption fuelled economic growth before to the global financial crisis of 2008. When the crisis hit, both of these categories of spending plummeted hard, and the investments meant to make up the shortfall never materialized. One of the primary tactics employed by the central banks around the world to try and increase employment and spending following the crisis was lowering interest rates, and it was partly successful. Investors were encouraged to bidding up the values of stocks and bonds by policies that kept market interest rates low and inundated the financial industry with liquidity. Through initial public offerings (IPOs), this encouraged investment along with certain consumption and resulted in financial opulence through capital gains.

But this policy is out of date and has cost unavoidable money. With rates of return at or close to zero, investors are encouraged to take out highly risky loans, which has increased leverage and lowered the quality of investments overall.

There is a genuine possibility that asset prices could decline sharply when central banks eventually reduce credit (Sachs 2016). But with monetary policy pushed to its breaking point, long-term lending and infrastructure funding were hard to come by, especially for renewable energy projects. Most countries, especially developing ones, lack the resources in the public sector to close this enormous investment gap, and business has not showed much enthusiasm either. The private sector has been hesitant to provide funding for long-term construction endeavors, including renewable energy projects, mostly due to the low rate of return and associated risks (Taghizadeh-Hesary and Yoshino 2018).

To examine the worldwide inquiry in the area of green finance and energy, this paper uses bibliometric tools to conduct an in-depth examination of the correlated articles in this field in the Scopus repository from 2000 to 2024, using various quantitative characteristics and visual representations of the available literature, in addition to using VOSviewer and MS Excel program to offer an exclusive and broad summary of the findings in this field, revealing the development.

1.1 Literature Review

When it initially emerged in the early 1900s, bibliometrics (Pritchard, 1969) became a separate field that has been figuratively applied to literary analysis (Diem & Wolter, 2013). In this research study, bibliometrics was employed effectively to communicate research findings on the data set presented. Bibliometrics is the use of statistical tools to analyse bibliographic data, particularly in academic library and information technology settings.

Numerous academic fields use bibliometric techniques to find extremely influential publications within a particular field of study or to examine the significance concerning their arena, a group of scholars, or a particular work. The analysis of bibliographic data using statistical methods is known as bibliometrics, and it has become a vital tool in many academic and scientific fields. It offers perceptive information about the effectiveness, significance, and cooperative methods used by researchers and institutions. Bibliometric indicators such as citation counts and journal impact factors are widely used to evaluate the impact of documentation (Cartes-Velásquez & Manterola Delgado, 2014), investigators (Ho & Fu, 2013; Larsen & Havemann, 2014; Lehrl, Jacob,& Henkel, 2007), and companies (D'Angelo, Abramo & Costa, 2011) because they make these assessments less time-consuming and more objective.

Scholars Ding et al. (2013), Pan, Yan, Wang, & Hua (2015), and Urquhart & Dunn (2013) have suggested that bibliometric parameters are useful to evaluate the effects of a wider variety of academic entities, such as diseases, software, data sets, illnesses, and medications, due to "most recent advances in technology and information services" and the growing significance of bibliographic analysis in assessing research (Belter, 2014). The analysis of individual scholars', departments', and institutions' achievements through bibliometrics is also crucial for managing talent and allocating resources. Moreover, bibliometric analysis can be employed to assess the impact of regulations, research funding, and other factors on scientific productivity. There are political and economic implications when the academic sector uses bibliometric criteria to determine rankings and other productivity indicators (Abbott et al. 2010; Harvey 2008). Initially, E. Garfield, the original founder of the National Institute for Scientific Information, emphasized the prospects for bibliometrics. Citation indexing was addressed in-depth in a number of Current Contents editorials, including Garfield's

(1977). The field grew rapidly in the years prior to the release of digital versions of the primary bibliographic databases (Wilsdon et al. 2015).

Bibliometric analysis is closely associated with the concept of "systematic review." Many scientists consider it to be the first and most important stage in the scientific method (Tranfield et al., 2003).

The purpose of a systematic evaluation is to provide a comprehensive inventory of the literature in a topic that is sometimes highly specialized. Statistical analyses of the increasing amount of available data enable realistic modeling of research development, collaboration, and rankings (Bornmann et al, 2014). A recent survey of the literature by Wouters et al. (2015) provided a list of papers covering a wide range of issues related to bibliometric science. In a recent work, Leydesdorff et al. (2016) distinguished four main actor categories: (1) manufacturers of bibliometric products, (2) bibliometricians, (3) managers, and (4) scientists. Many scientists and managers have to understand research report findings while following the limitations of applied bibliometric methodologies because they deal closely with these systems. Without ever checking bibliometrics, research managers can acquire these study reports from these websites. This increases the generalizability of the literature's presentation and bibliometric methodology discussions to all communities. In summary, bibliometrics is a vital tool for scholars, decision-makers, and administrators because it offers a quantitative and practical paradigm for understanding the evolving nature of research and knowledge development.VOSviewer is an example of a tool that is used to generate and display bibliometric maps. The application is available without charge to the bibliometric research community. VOSviewer can be used, for example, to construct mappings of authors or publications based on co-citation data or maps of keywords based on co-occurrence data. A viewer made possible by the software allows for bibliometric map analysis to be done in-depth. VOSviewer offers multiple ways to display a map, each emphasizing a different aspect of the map. Its zoom, scroll, and search tools make it simpler to look at a map closely. The viewing capabilities of VOSviewer are especially useful for maps that have at least a fair number of things (e.g., at least 100 objects).

1.2 Research Objectives

Examining the most current advancements in the discipline of green financing research is the aim of this study. This study makes an effort to clarify this significant subject by integrating bibliometric and qualitative assessment. These stand for the major goals of the study:

1. To gather, classify, and highlight the key topics in the body of extant green energy literature.
2. To determine the most often used keywords by scholars in this field.
3. To evaluate publishing patterns and pinpoint top journals at the intersection of economic expansion and environmental sustainability.
4. To apply bibliometric techniques to undertake a thorough examination of the present and potential future paths of ecological and sustainable finance.
5. To pinpoint important gaps, make fresh research recommendations, and assess advancements in worldwide research.

1. **Research Methodology**

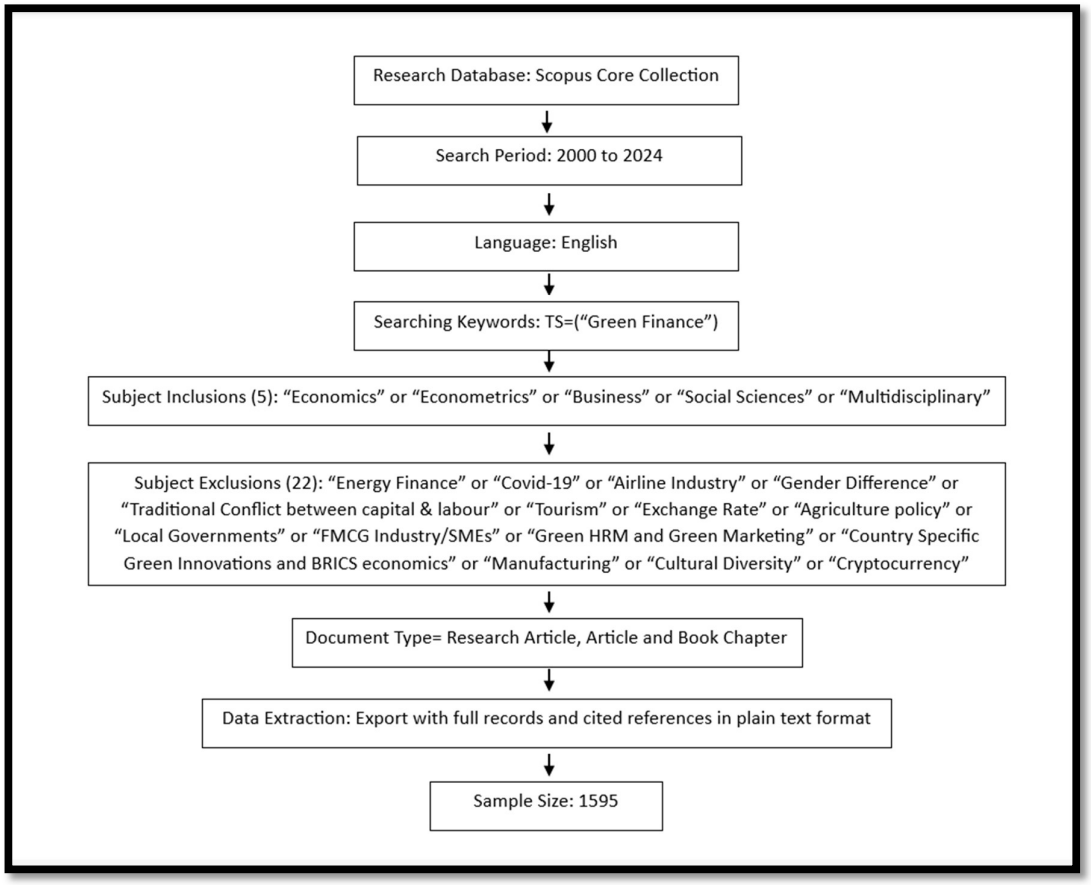

Fig 1 Data Extraction

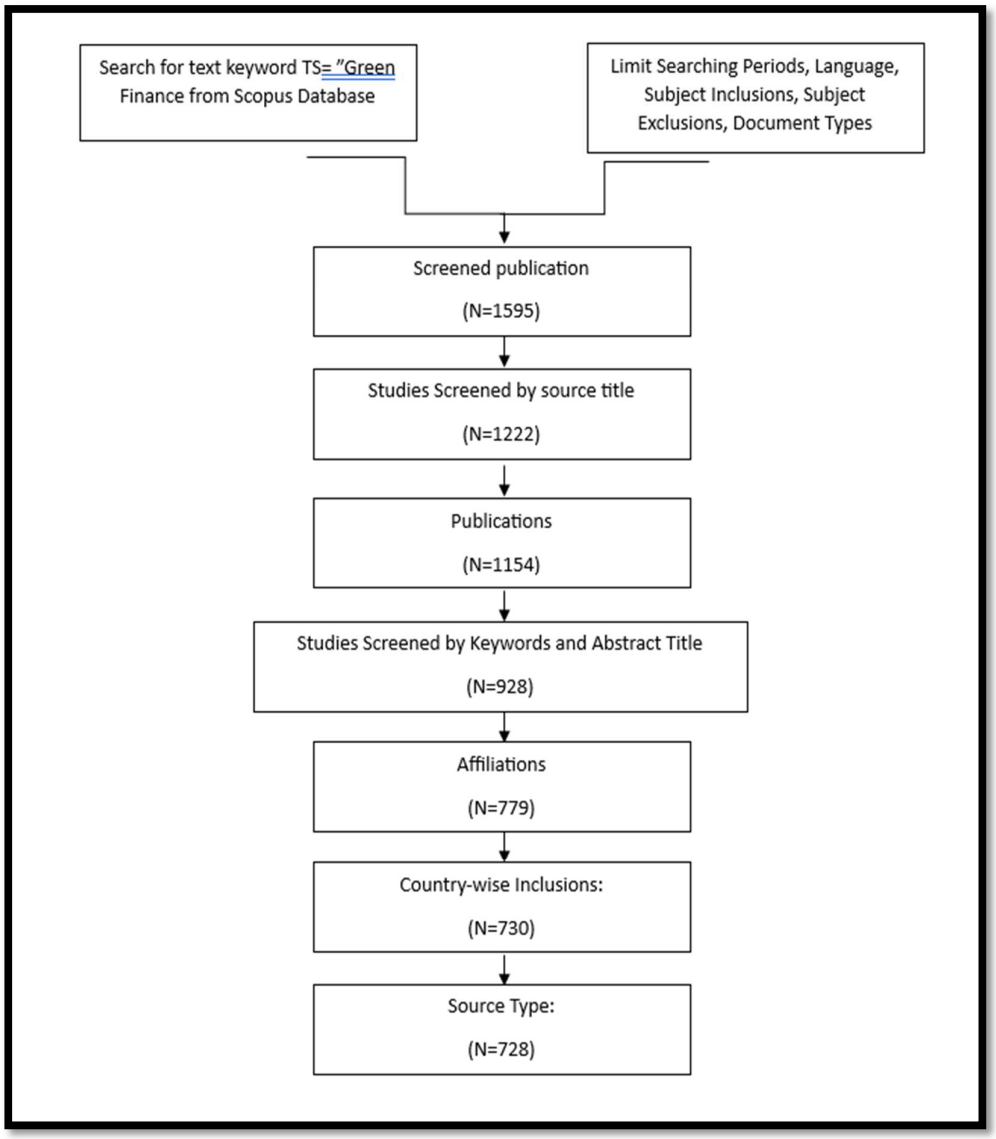

Fig 2 Systematic reduction of Sample Size

Applications like VosViewer and MS Excel were employed to get an accurate representation of the citation evaluation in this study. A software program called VOSviewer is used to create and display bibliometric networks. These networks can be constructed via citation, bibliographical coupling, co-citation, or a co-author links, and they can comprise journals, researchers, or individual publications. Additionally, VOSviewer contains text mining features that let you build and visualize nodes of important terms from scientific articles.

The Scopus Core Collection was selected to be a research repository for this study because of its renown for providing high-quality digital literature resources and because it is widely acknowledged by academics as a few of the best databases for conducting bibliometric analyses. With more than 80 million records, Scopus is a comprehensive database that includes books, book chapters, conference papers, and articles. Researchers can access a wide variety of scholarly publications from many areas thanks to this comprehensive coverage.

In **Figure 1**, various data sources and their selection criteria are outlined. The initial literature search was performed using the Scopus database on 3rd July 2024, applying Boolean operators to identify relevant studies with the keyword TS= ("green finance"). The search was limited to publications from 2000 to 2024, and only English-language sources were considered. The search focused on seven key subject areas: Economics, Econometrics, Business, Social Science, and Multidisciplinary fields. To avoid complicating the dataset, several topics were excluded, including "Energy Finance,"

"COVID-19," "Airline Industry," "Gender Differences," "Traditional Conflict between Capital and Labour," "Tourism," "Exchange Rate," "Agriculture Policy," "Local Governments," "FMCG Industry/SMEs," "Green HRM and Green Marketing," "Country-Specific Green Innovations and BRICS Economies," "Manufacturing," "Cultural Diversity," and "Cryptocurrency. "Only research papers, articles, and noteworthy book extracts were allowed to be used as document types. Subsequently, the data was exported in plain text format, including the citations mentioned. 1,595 journal papers and articles were the sample size produced by this approach. **Figure 2** illustrates the systematic reduction of the sample size through multiple screenings and divisions. Initially, the selection of various source titles reduced the sample size to 1,222 and further classifications within the publications brought it down to 1,154. Subsequent screenings were conducted to include or exclude specific keywords and abstract titles related to 'green finance,' which further reduced the sample size to 928. The figure was reduced to 730 by further filtering based on affiliations and inclusions particular to each country. Ultimately, 728 credible articles were identified and selected as the study's sample following an empirical evaluation of the various source sources. All of these steps were done with great care to guarantee that the research volume matched the study topic and was precise.

2. Descriptive Statistics Generation

Because green technologies carry higher risks and yield poorer returns than fossil fuels, financial institutions have historically been more interested in fossil fuel initiatives than in green ones. Nonetheless, the state of the world today necessitates a major investment in clean energy sources and a stop to the development of new coal-powered power plants. Along with a reduction in the number of vehicles produced with internal combustion engines, there is also an urgent need to make significant investments in electric vehicles and cutting-edge battery technologies. Particularly developing nations need to make large investments in extending their educational and health systems, as well as in sanitation and water improvements in areas that are quickly urbanizing (Yoshino et al., 2019).

Considering these factors in detail, this study utilized 400 papers authored by 943 individuals from over 70 countries, with a primary focus on Asia, Europe, and Africa. These authors are affiliated with 792 organizations and research institutions. The research methodology employed a comprehensive approach, incorporating network diagrams and tables to illustrate various citations, keyword occurrences, and document frequencies. The fragmented, diversified, and interdisciplinary nature of the research findings is successfully captured by this approach. The ensuing sections will go into the results of these analyses.

3.1 Bibliometric Analysis of the Authors

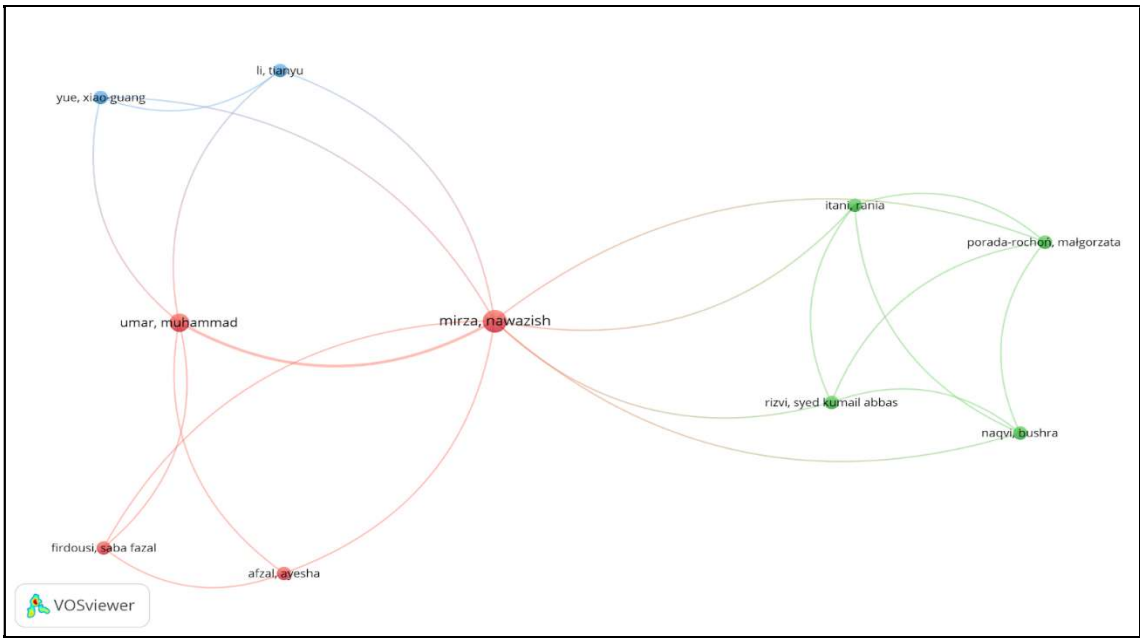

Fig 3 Network Analysis of Authors

In **Figure 3**, from the 943 authors contributing to 400 documents, 10 were selected based on their interconnectedness, measured through link strengths and citation counts. Authors who published at least one document and received 20 or more citations were identified as the core contributors to the field. These key authors published their findings between 2020 and 2023, as indicated by the Scopus data.

The author rankings were determined using full counting rather than fractionalized counting. In full counting, a co-authored publication is assigned a full weight of one for each co-author, meaning the total weight of a publication equals the number of its authors. Conversely, fractional counting assigns weights to actions such as co-authoring and citing publications, distributing the overall weight among the contributors.

Table1. Author Citation Title Wise

Rankings	Authors	Documents	Citation	Average Citations	Average Publishing Year
1	Mirza, Nawazish	3	184	61.33	2022
2	Umar, Muhammad	2	73	36.5	2023
3	Itani, Raina	1	111	111	2021
3	Naqvi, Bushra	1	111	111	2021
3	Porada-Rochoń Małgorzata	1	111	111	2021
3	Rizvi, Syed Kumail Abbas	1	111	111	2021
7	Afzal, Ayesha	1	53	53	2023
7	Firdousi, Saba Fazal	1	53	53	2023
9	Li, Tianyu	1	20	20	2023
9	Yue, Xiao-Guang	1	20	20	2023

In **Table 1**, the rankings of the 10 authors were determined based on the number of documents they published. Among them, Mirza-Nawazish stands out as the most prolific and highly productive author, with 184 citations across three published documents. This author collaborated with others, including Firdousi-S.F and Afzal-Ayesha, who each have 53 citations and share an average publication year of 2023. The average number of citations reflects a publication's citation impact, which is calculated relative to the average number of citations for all publications from the same year within the data set.

3.2 Bibliometric Analysis of the Organization

To evaluate the contributions of educational organizations and other institutions in this field, this paper analyzed data from 792 organizations. Of these, 13 were selected for detailed examination. The graph below uses Overlay Visualization via the VOSviewer tool to illustrate the clusters and nodes representing the number of citations and the connections between them. The selected organizations are from countries such as France, Lebanon, Pakistan, and China. With a minimal threshold of one document per organization, the analysis produced 13 interconnected institutes in **Figure 4**, with a maximum total connection strength of 10 nodes.

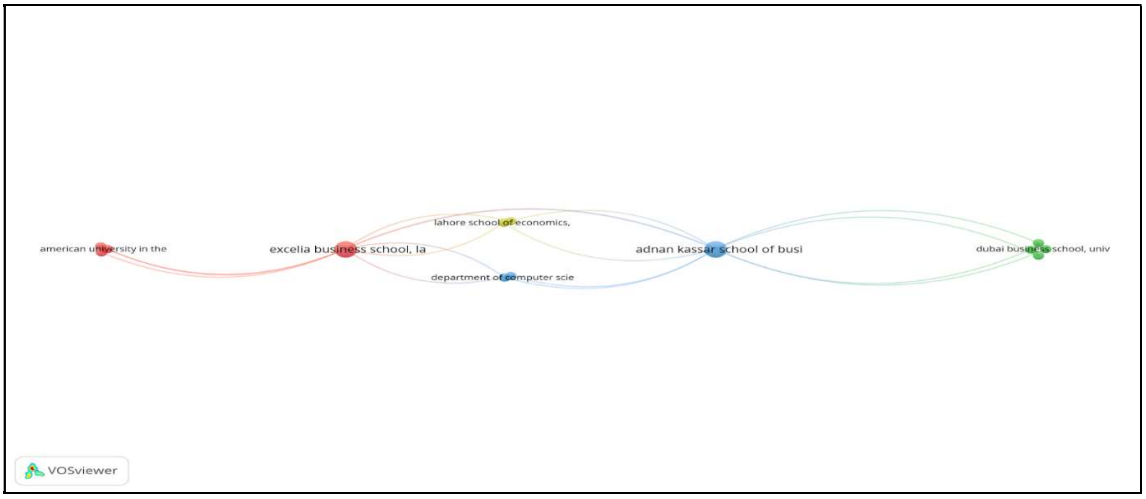

Fig 4 Network Analysis of Organisations

Table 2. Top 5 organisations in the field of green finance based on citations

Rankings	Organisations	References	Links	Mean Citations	Mean Publishing Year
1	Excelia Business School, France	184	8	61.33	2022
2	Adnan Kassar School of Business, Lebanon	73	9	24.33	2023
3	Lahore School of Economics, Pakistan	53	3	53	2023
3	School of Economics, Qingdao University, China	53	3	53	2023
5	School of Business, Hubei University, China	20	3	20	2023

Table 2 presents the ranking of five organizations based on their average publication years from 2022 to 2023. The Excelia Business School in La Rochelle, France, leads with the highest number of citations, totaling 184, and an average citation count of 61.33. This is followed by the Adnan Kassar School of Business in Beirut, Lebanon, with 73 citations and an average citation of 24.33. Other institutions, including Lahore School of Economics and Qingdao University in Shandong, Qingdao, each have 53 citations and an average publication year of 2023.

Utilizing resources and green financing are areas of interest for researchers like Li, T., Umar, M., Mirza, N., and Yue, X.-G. These researchers are connected to the Hubei University School of Business in Wuhan, China; the Excelia Business School in La Rochelle, France; and the Adnan Kassar School of Business at the Lebanese American University in Beirut, Lebanon. Their study focuses on the recent spike in the use of fossil fuels, which has resulted in a scarcity of fossil fuel reserves and environmental damage. This circumstance emphasizes how urgently more renewable energy must be produced to meet the tremendous energy needs of the energy-demanding industries in developing countries. Li et al. (2023) conducted a study with the principal objective of analyzing the effects of natural resource rents and green financing on ecological sustainability in the Next Eleven (N-11) nations between 2001 and 2018.

These businesses also conducted a study that looks at how financial technology, or fintech, may improve productivity and green financing. This study examines the association between adoption of fintech and bank profitability by using a panel fixed- effect regression model to assess a large sample of European financial institutions from 2011 to 2021. According to Mirza et al. (2023), there is a favorable link between investments in financial technology and green lending. This correlation can be due to advancements in search, diligence, and monitoring efficiency that come with new technologies. These studies provide insightful information on the current state of green funding and its difficulties.

3.3 Bibliometric Analysis of the Countries

This study looked at the number of articles from over 70 countries, with an emphasis on Asia, the Middle East, Europe, and Africa, in order to assess the input provided by different nations to this field of study. The analysis visually displayed nations with at least three documents using VOS viewer as the main tool. As a result, 41 nations are shown in the graph as having satisfied this requirement. Larger nodes in **Figure 5** indicate an increased amount of publications. Nodes of different col ors relate to distinct clusters. The distance between nodes is represented by the degree of thickness of the lines linking them; thicker lines indicate more frequent collaborations. According to Tao and Chao (2023), the findings indicate that the quantity of nations making contributions to this subject is quite small and not uniformly distributed. A notable percentage of the publications in this field are written by study participants from a small number of countries. Conversely, **Figure 6** presents a global map that displays the quantity of authors that have been cited and published between 2015 and 2024 on subjects including corporate bonds, green bonds, and sustainable finance. The different blue hues in these countries indicate the frequency and matching quantity of papers published. The nations with the greatest representation below the map were China and the US; their blues were more intense than those of the other nations. Research papers were more common in North America, Europe, Asia, and Oceania than they were in other continents, such as Africa and South America. In terms of the total number of articles published, the top 5 Asian countries were China (92), India (49), Malaysia (14), Pakistan (10) and Vietnam (10). Most European publications were released in countries such as the UK (49), Germany (21), France (18), and Italy (14). These figures are essential for demonstrating the distribution of individuals throughout the world and their concerns regarding green finance and environmental sustainability.

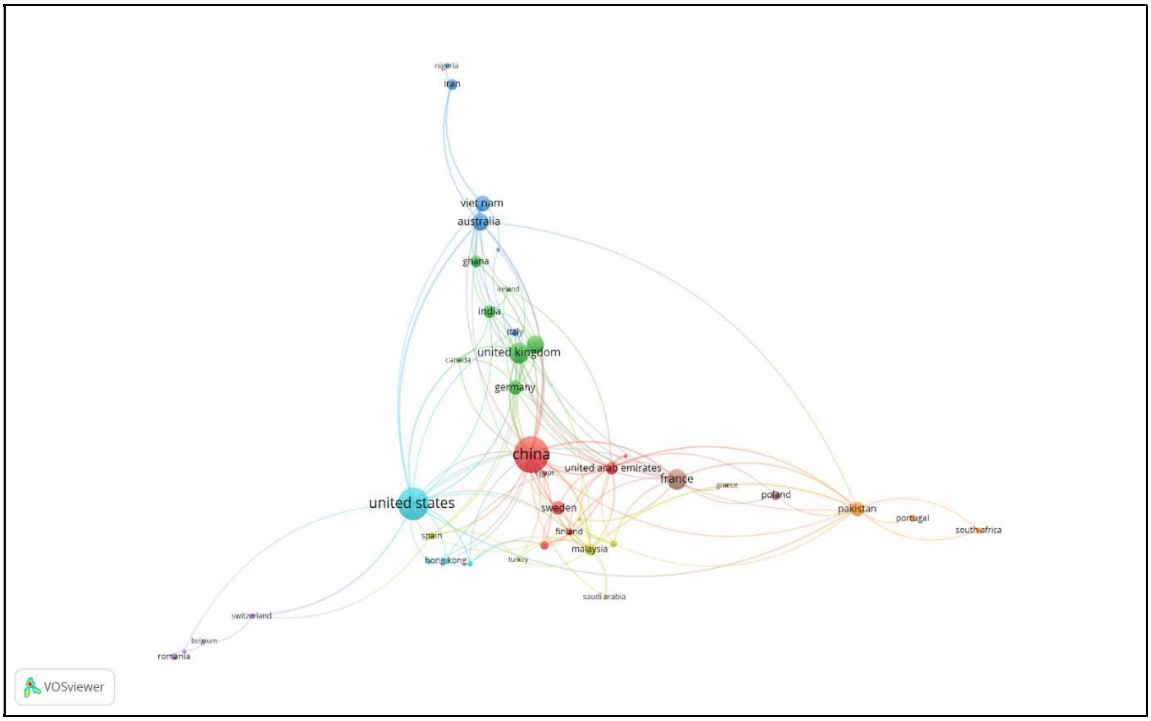

Fig 5 Network Analysis of Countries

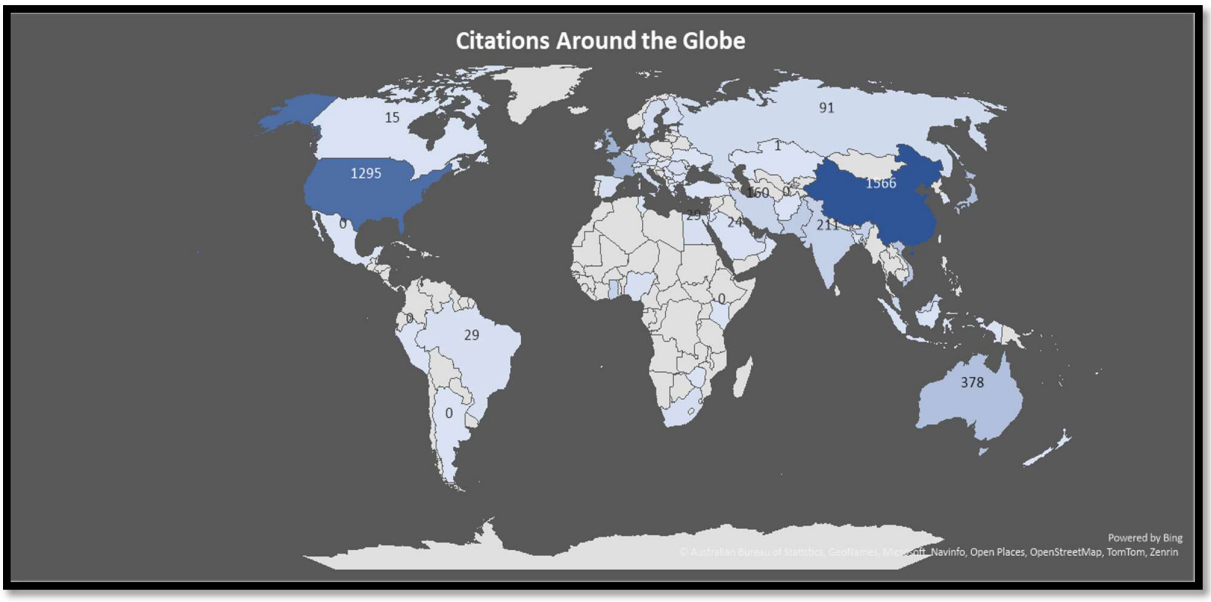

Fig 6 Global Mapping based on Citations

Table 3. Top 10 countries with the most publications in the field of green finance

Rankings	Country	Documents	References	Mean Publishing Year
1	China	92	1566	2023
2	United States	51	1295	2018
3	United Kingdom	49	517	2019
3	India	49	211	2022
5	Germany	21	259	2020
6	France	18	530	2022
7	Australia	17	378	2019
8	Malaysia	14	156	2023
8	Italy	14	80	2021
10	Canada	13	15	2021

The top 10 nations with the most documents produced on green finance between 2018 and 2023 are shown in **Table 2**. According to the data, Chinese scholars have produced the largest number of documents, totalling 92, and have garnered the highest citation count. Following China is the United States, with 51 documents and 1,295 citations. The United Kingdom and India each have 49 documents, with average publication years of 2019 and 2022, respectively. Malaysia and Australia each have 14 documents, with average publication years of 2023 and 2021, respectively. In contrast, Greece, Ukraine, Ireland, Austria, and Hungary have the fewest documents, with each having three, citations ranging from 0 to 4, and a maximum total link strength of 5. According to recent research, Chinese academics have concentrated on issues including high-tech innovation and green finance in sustainable development, the evolution of municipal debt, the market

for green bonds, and green innovations (L., T., Sun, H., Sun, Pu, Zhang, H., & Chen, Z., 2024). The Yangtze River Industrial Ring and its long-term growth through technological innovation have also received a lot of attention. Researchers in India have investigated how blockchain and digital twin technologies might be used in green finance to combine environmental sustainability and financial innovation (Khan, M., Ebrahim, M.S, Rahman, A., & Fatima, H., 2024). Sustainable investments, issuing green bonds to increase equity share market returns (Kodiyatt, S.J., Nair, Jacob, M.S, Reddy, K., B.A.V. 2024), and managing digital transformation (Pal, S., Singh, M., & Sharma, M., 2024) are some other study subjects in India. India, home to 1.4 billion people, has a major influence on global greenhouse gas emissions and environmental degradation. India ranked third in the world for greenhouse gas emissions in 2021, behind the United States and China, with 3.9 billion tonnes of carbon dioxide (CO2) released into the atmosphere. Despite this, India has comparatively low per-capita greenhouse gas emissions—2.8 CO2-equivalent tonnes—when linked to the worldwide averages of 6.9 and 17.5 in the US. As part of the Paris Agreement, India's climate targets for 2030 call for a 50% installed capacity share of non-fossil fuel-based energy sources and a 45% reduction in carbon emissions from 2005 levels. The nation has to spend about $170 billion a year to accomplish these goals and other obligations, yet the average amount of climate finance flows available today only amounts to $44 billion annually.

3. Keyword analysis

To clearly and concisely explain the major points of a research study and provide current themes in the financial and scientific domains a purpose, keywords are essential. The 400 research papers and articles in this study have their keyword co-occurrence charts plotted using VOSviewer. Out of the 1056 terms, 156 had at least two occurrences, satisfying the criteria. Figure 5 shows the density visualisation of multiple keywords to gauge their frequency of occurrence, and **Figure 7** shows the network visualization of multiple keywords. The stronger the relationship between two nodes—stronger lines indicating more frequent co-occurrence within the same literature—the larger circular nodes in Figure 7 imply higher keyword frequency and greater importance in the area. Research themes and various clusters are represented by the colours of the nodes. High-frequency terms that appear more than 30 times are given in Table 5 to give a more readable picture. High-frequency keywords like green finance, climate change, sustainable finance, green bonds, and green digital financing, are crucial to this subject, as shown in Figure 7 and **Table 4**. From 2019 through 2023, the majority of these terms will be popular.

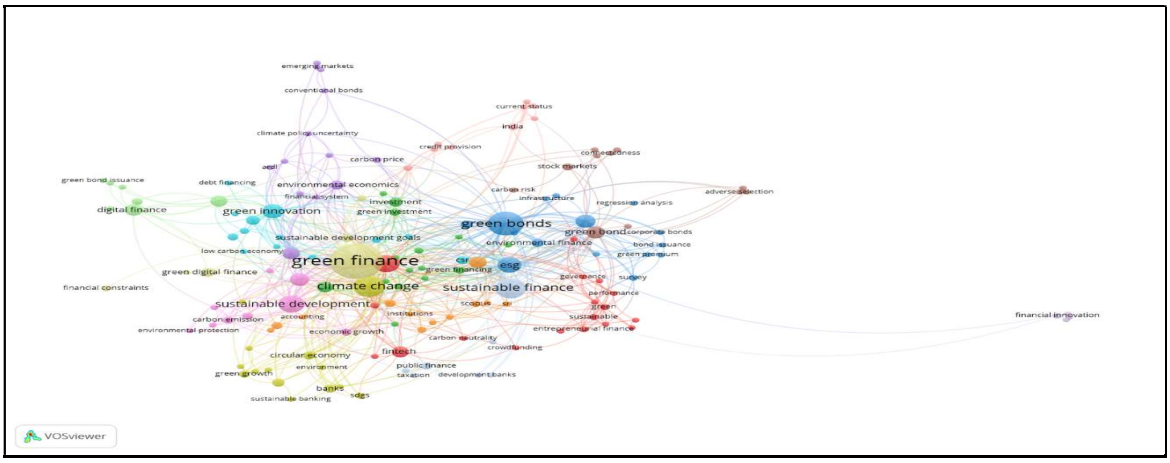

Fig 7. Visualisation of Keyword Analysis

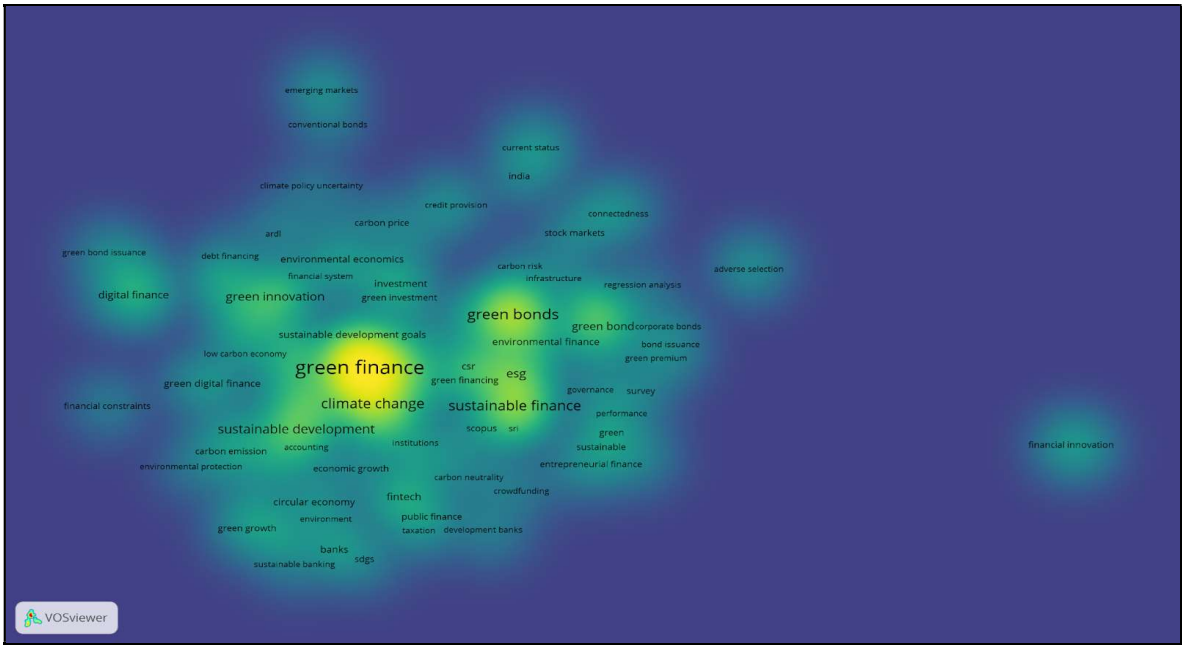

Fig 8. Density Visualisation of 156 keywords

Figure 8 displays the density of keywords; both the frequency and density of a keyword increase with color similarity to yellow. The intricate visualization facilitates the explanation of the overall framework of the field's studies. Important terms like "green finance," "green bonds," "climate change," "ESG," and "impact" are cantered in the visualization network chart, suggesting that future study would likely concentrate on these topics. Green financing study now intersects with the fields of environmental research, power behavioural science, finance, econometrics, and economics as well as management, commerce, and the accounting profession. Given the range of viewpoints that are used to examine it, it is evident that green finance is a multidisciplinary topic with themes that regularly cross over across banking and scientific professions.

Table 4. Keywords with a frequency of more than 10

Rankings	Keywords	Occurrence	Total Linkage Strength
1	green finance	89	54
2	green bonds	41	39
3	climate change	31	39
4	sustainable finance	30	30
5	sustainability	22	24
6	sustainable development	21	24
7	esg	18	24

8	green innovation	15	10
9	climate finance	13	15
10	Green economy	12	15

For terms with a frequency higher than ten, Table 4 shows the total number of occurrences as well as the connection strength. "Green finance" is the most popular keyword, with 89 occurrences and a link strength of 54. Publications from countries like China, Tunisia, Bahrain, India, and Ireland frequently publish research articles debating whether green financing and technological innovations promote climate justice, facilitate the green transition, and aid in sustainable development in the Global South. These studies also examine the potential advantages of green financing for the tourism sector and its role in environmental sustainability. To illustrate, the terms "Bond Issuance," "Capital Markets," "Corporate Performance," and "Socially Responsible Investing" have two instances each, but a total linking strength of nine. Table 4 is graphically represented in **Figure 9** by mixing bar and line charts to show these keywords. "Occurrences" is shown as a bar chart, while "total link strength" is shown as a line chart. While the right side of the frequencies displays the overall link strength in an increasing format (from right to left), the left side displays the "occurrences" of these keywords in a decreasing sequence (from left to right). Instead of the table's simple text format, these analyses are necessary for a better graphical and pictorial portrayal.

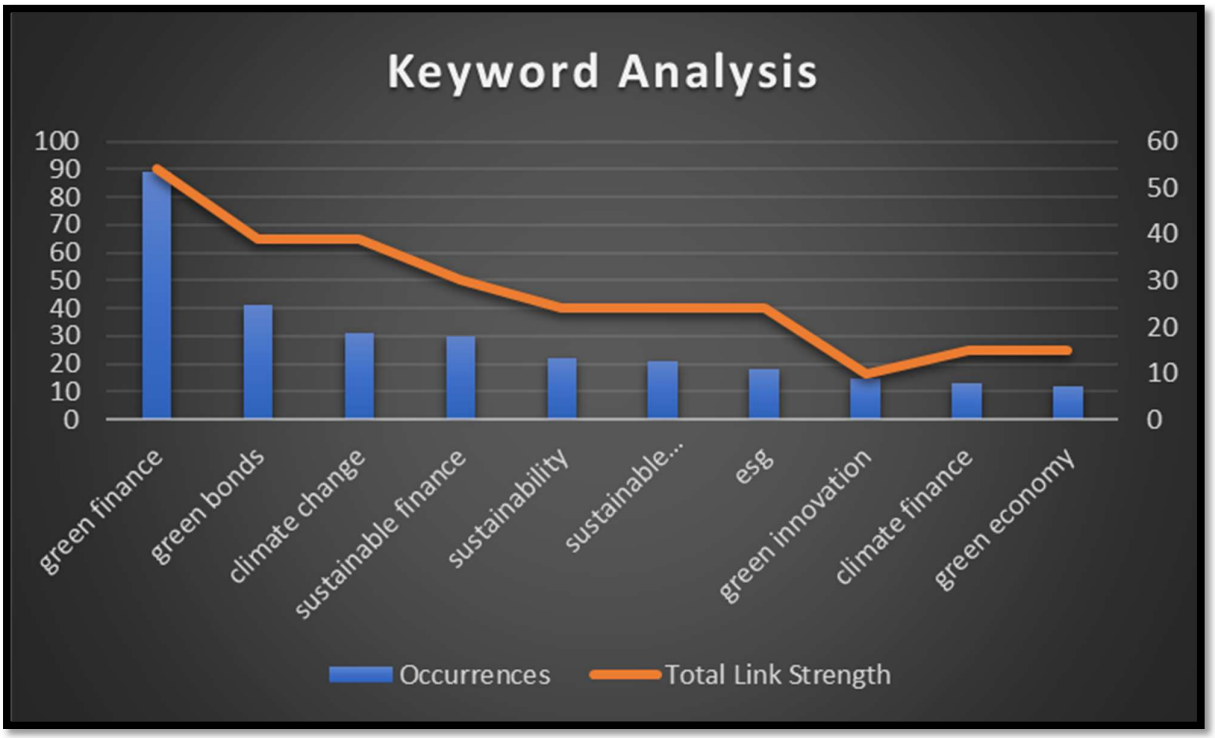

Fig 9 Graphical Representation of Top10 Keywords

4. Thematic Map

A thematic map is used to examine and illustrate key themes in quantitative research within a conceptual framework on a Cartesian plane. Accurate data is essential for identifying significant themes for further analysis. To enhance efficiency, themes are assessed based on the interaction and association between different topics using Callon's centrality metric. Callon's centrality is a network analysis tool that evaluates the importance of specific nodes or clusters within a network, focusing on the strength of relationships and overall network structure. Unlike traditional centrality measures, such as degree centrality, which counts the number of connections, Callon's centrality examines both the strength of these

connections and their network context. Key components include the development index (density), which gauges the strength of connections within a cluster, and the relevance degree (centrality), which measures the cluster's external interactions.Research subjects are categorized using a matrix structure with four quadrants in **Figure 10**. The motor or main theme, which is located in the top right and has high prominence and concentration, is followed by the basic or foundational theme, which is located in the bottom right and has high centrality but low density, the niche theme, which is located in the upper left and has high density but low prominence, and the emerging or dissipating theme, which is located in the bottom left and has low density but high centrality. The map's rectangles show how much certain themes have been studied and point to places that still require investigation (Rao, Talan, Taghizadeh-Hesary & Abbas, Dev, 2023).

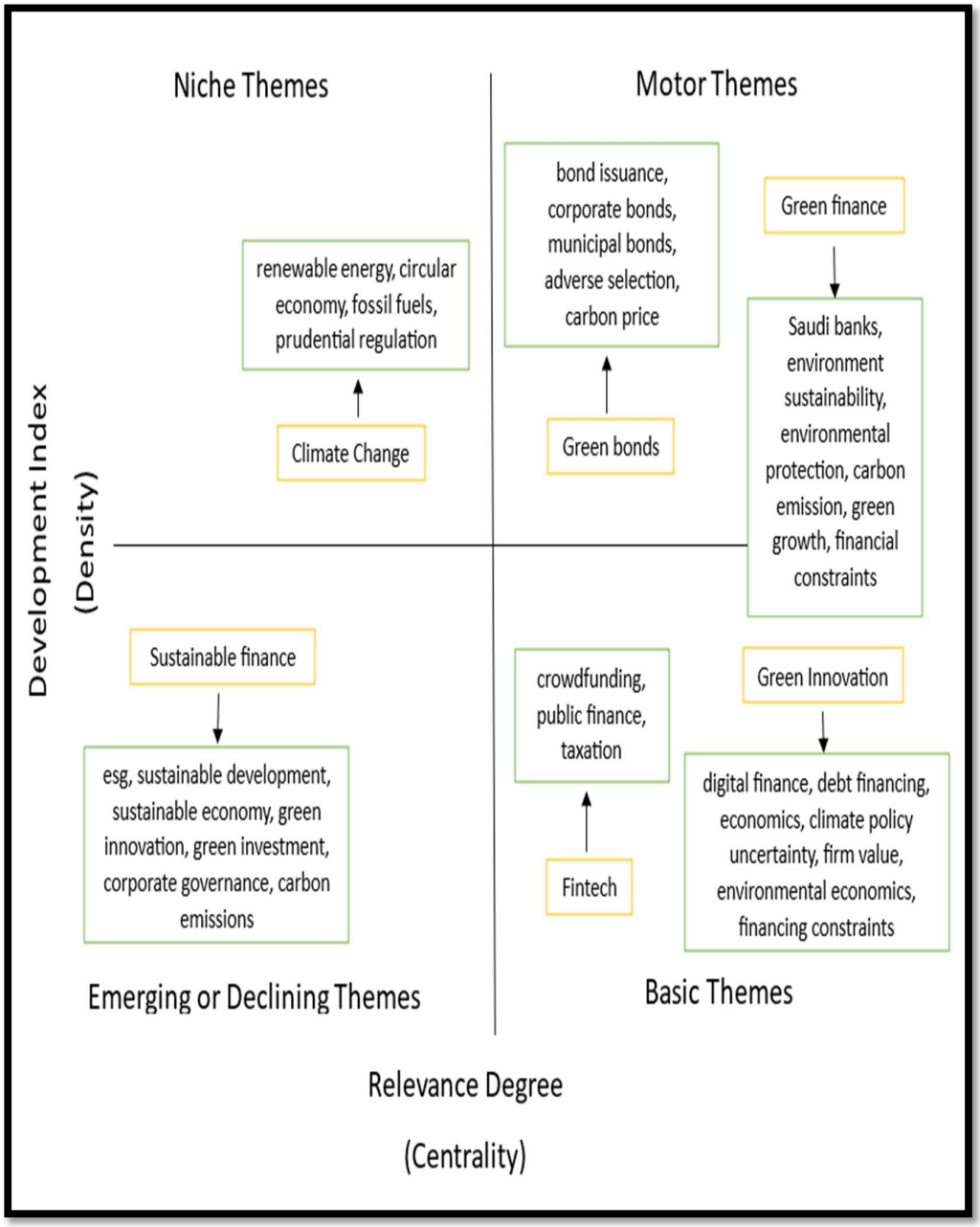

Fig 10 Thematic Analysis

5.1 Motor Themes

This category's two main subjects are "Green Bonds" followed by "Green Finance." Keywords like "Saudi banks," "environmental sustainability," "environmental protection," "carbon emissions," "green growth," and "financial constraints" are all included in the focus of "Green Finance." The critical nature of green finance and its significance in advancing environmental sustainability have received more attention in recent times. The increasing environmental crisis—which encompasses biodiversity loss, resource depletion, and climate change—is the reason for this increased focus. A subgroup of sustainable finance known as "green finance" seeks to promote financial strategies and investments that produce favorable environmental results in addition to financial rewards (H. M. N. K. Mudalige, 2023).

In contrast, Green Bonds encompass terms like "adverse selection," "corporate bonds," "municipal bonds," "bond issuance," and "carbon pricing." A crucial query that arises with the growing importance of green financing and its compatibility with conventional financial markets is if it has the ability to impact the dynamics of international markets. The influence of alternative financial instruments, particularly green equity indexes, on international equity markets is still little understood, despite the fact that knowledge on green finance is evolving. The studies that are now available frequently concentrate on certain geographical markets, as those in the China, USA, or Europe. Though they may not fully explain how sustainability factors in green finance impact trends in the global market, these studies provide insightful information about the dynamics of green finance in specific regions. There are indications of a possible change in the dynamics of the global market, with green markets starting to have an impact (Sofia Gomes, Tiago Trancoso 2024).

5.2 Basic Themes

"Fintech" and "Green Innovation," which concentrate on the technological aspects of promoting environmental sustainability, are the main subjects in this quadrant. Key phrases related to the theme of "Fintech" include "crowdfunding," "public finance," and "taxation." Utilizing cutting-edge technology like carbon capture and storage to lower carbon emissions is becoming more and more popular. Government and environmental experts have indicated that to effectively limit global warming to either 2°C or 1.5°C, pollutants must be decreased by 30% and 45%, respectively, relative to forecasts based on present policies (Litterman et al., 2020). The financial system is increasingly being targeted to drive transformative changes across all sectors. Efforts include enhancing the efficiency of financial markets, implementing carbon pricing, influencing financial behaviour, developing markets for low-carbon technologies, mobilising central banks, and establishing international climate partnerships and initiatives (Muhammad Abubakr Naeem et al., 2024).

Keywords like "digital finance," "debt financing," "economics," "climate policy uncertainty," "firm value," "environmental economics," and "financing constraints" are all included in the Green Innovation subject. Studies have examined how corporate green innovations is impacted by external funding limitations and environmental legislation (2023, Li et al.). There is continuous interest in comprehending monetary stability as well as sustainability within the structure of fiscal policies, even if the majority of research has concentrated on macro-level effects. While these areas have been studied, research on the relationship between macroprudential policies and enterprise-level behavior is lacking (Ding and Ding, 2024; Tarassow and Greenwood-Nimmo, 2016; Xin Lin et al., 2024).

5.3 Niche Themes

The present focus of the niche theme is "climate change," which encompasses elements like "fossil fuels," "renewable energy," "circular economy," and "prudential regulation." According to Tolliver et al. (2021), The Paris Climate Agreement's ratification in 2015 brought the idea of "green finance," which has been around for twenty years, widespread attention. This change is mostly attributable to financial institutions' growing cognizance of climate concerns. As per Caldecott et al. (2021), these institutions have been encouraged by authorities and regulators to identify and disclose to investors the climate risks connected with their asset portfolios. With the passage of Article 173 of the Law on Energy Transitions on August 17, 2015, the movement got its start in France. It then spread throughout the world as a result of the recommendations made by the Financial Stability Board's Committee on Financial Disclosures Related to Climate Change, which was made up of major international organizations and central banks (Chenet, 2019). Accordingly, any financial endeavours promoting energy transition and reducing global warming are included in the category of "green finance" (Boissinot et al., 2016). The green finance industry has grown significantly and is still growing since the World Bank issued the first green bond in 2008. Promoting environmentally friendly investments that ease the

transition to a more sustainable state is its main goal. Numerous parties, including banks, private savers, and major investment funds, endorse this objective (Lindenberg and Berensmann, 2019; Chenguel & Mansour, 2022).

5.4 Emerging or Declining Themes

The prominent emerging theme is "Sustainable Finance," encompassing concepts such as "ESG," "sustainable development," "sustainable economy," "green innovation," "green investment," "corporate governance," and "carbon emissions." Despite its increasing relevance, a universally accepted definition of sustainable finance remains elusive. The European Commission describes sustainable finance as "the practice of incorporating considerations related to the environment, society, and governance (ESG) into investment choices within the financial industry, thus encouraging investments that last in sustainable economic activities and undertakings." A description akin to this is used by the World Bank to describe sustainable finance (Yimer, G.A., 2024).

Findings

Financing ecologically sustainable initiatives is essential due to the pressing need to combat climate change and its negative environmental repercussions. As a result, "green finance" has become more and more common within financial and economic works. This paper, which is based on a review of 400 publications written by 943 people from over 70 countries between 2000 and 2024, uses bibliometric analysis to chart the intellectual evolution of green finance research. Despite the very early occurrence of the term "green finance" in academic literature, there has been a notable surge in scholarly activity after 2022. China is notably in the forefront of green finance research, both in regards to independently conducted studies and cross-border partnerships. The bulk of papers in the interdisciplinary field of "green finance" are published in journals that address sustainability and environmental challenges. Green finance is the integration of environmental sciences and finance.

5. Conclusion & Discussion

Our research offers insightful information about the present situation of the quickly developing realm of green financing. Future studies should concentrate on a number of important topics, such as the creation of novel green finance instruments, the function of the private sector, pricing carbon emissions, threat reduction in green financing, carbon offset mechanisms, and the evaluation of the societal effects of green finance initiatives. Fostering international cooperation and research efforts from a varied range of countries is vital to getting a thorough knowledge of the issue, especially given the global character of green finance. Our findings are especially pertinent to the shift to a green economy and provide funding organizations and academics with recommendations on how to prioritize research that is essential to achieving the goals of the green economy.

However, there are limitations to this study. It is based solely on the Scopus database, which may exclude significant research from other sources. Additionally, bibliometric analyses rely on authors' keywords, which can sometimes be inaccurately chosen or incomplete. This limitation may affect the results, particularly in the clustering of research themes and the identification of emerging topics.

6. Future Research Directions

This research provides insightful information to help policymakers create more evidence-based and successful policies to aid in the shift to a green economy. The results have a number of significant policy consequences. First of all, they offer a thorough summary of the present situation of green finance study today, emphasizing the most well-known and active fields of inquiry. This knowledge may direct the creation of focused policy initiatives to support the shift to a low-carbon economy, encourage investment in environmentally friendly enterprises, and advance sustainable finance. Second, the outcomes help policymakers prioritize projects pertaining to green finance and make well-informed judgments. Lastly, the results of the study regarding collaborative networks highlight the significance of cultivating alliances across academic institutions, governmental organizations, and business partners. These kinds of partnerships can close the knowledge gap between policy and research, resulting in more successful policy outcomes.

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