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Evolution of Sustainable Finance and its Opportunities: A Bibliometric Analysis

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Abstract **- With the worldwide promotion of sustainable development, companies across all sectors strive for high profitability while prioritizing the balance between human activities and the natural environment. Sustainable Finance (SF) is proposed in response to this context. This article retrieves 650 papers on SF and energy policies from the Web of Science and Scopus database. Initially, the research does an analytical, statistical analysis that includes several aspects, such as general growth, publishing sources, research locations, and prominent scientific research institutes. The research uses the clustering method to identify the prevailing areas of study in recent years and forecast future research directions. This research identifies significant publications, esteemed experts, discoveries, and forthcoming SF and energy policy research areas. This study enables a systematic and thorough comprehension of SF and energy policy studies. Future research opportunities lie in sustainable bonds, government aid, and greenhouse gas emissions. Future investigations can be conducted by integrating Fintech, big data, and blockchain technology.**

Keywords**: Sustainable Finance, Bibliometric Analysis, Sustainable Development, Statistical Analysis**

I. SUSTAINABLE FINANCE AND ANALYSIS

Sustainable Finance (SF) is crucial in mitigating the risks associated with global warming and environmental damage (Cunha et al., 2021). It establishes a robust basis for enduring expansion and environmentally-friendly progress. Stern identified climate change as the most significant instance of market failure and a distinct economic issue. The genesis of SF is traced back to a sustainable ecosystem. The idea originated in Western nations, the first to experience the consequences of fast industrialization on the environment and climatic circumstances. The increasing apprehension over climate change prevention and environmental preservation has driven several industrialized nations and worldwide organizations toward achieving sustainable and environmentally friendly economic expansion (Su et al., 2020). Global platforms have used various strategies in previous years to promote SF and its associated projects. The initiatives encompass the implementation of equator rules, the promotion of SF and digitization, the setting up of sustainable industrial money, sustainable assets investments, sustainable bonds, sustainable financial institutions, sustainable insurance coverage, and the creation of a sustainable banking system that incorporates carbon financing, among other measures (Rohit, 2022). Given the increasing significance of financial institutions, several research groups and international organizations have focused on formulating a systematic definition of SF. The financial sector, environmental protection, and economic development converge in SF. Climate accounting, carbon accounting, environment accounting, and SF similarly refer to green financing (Brander et al., 2021).

The investigation report has distinguished climate accounting, sustainable accounting, and sustainable banking depending on their respective areas of concentration. SF encompasses funding both environmental adaption and mitigation efforts, including climate financing (Baldi et al., 2020). The sustainable banking system includes a set of policies, facilities, and institutional arrangements that guide private investment towards sustainable industries through various financial services such as credit, insurance, equity investments, bond and stock issuance, and others. An example of such a system is China's sustainable banking information system.

This work aims to conduct a bibliometric analysis of the chosen literature to overview SF comprehensively (Hajek, 2022). The research seeks to identify the factors supporting SF activities' growth and explore opportunities for future study (Utomo & Latukismo, 2022). The research will contribute to the existing literature on SF, providing more material for theoretical and empirical examination (Arora, 2024). In future studies, the selected list of facilitators is analyzed using quantitative and qualitative methodologies.

The study intends to examine and explore various topics related to SF and its facilitators.

RQ-1. What are the primary scholarly interests associated with SF, taking into account citations, researchers, and geographical activities?

RQ-2. What are the often-cited concerns in the literature that has been chosen?

RQ-3. What are the significant factors that facilitate the adoption of SF as addressed in the existing literature, and what are the potential areas for future study in SF?

The work adds to the existing body of research on SF by providing a thorough analysis of the rapidly expanding idea of SF. The research aims to provide a comprehensive and inclusive understanding of the field by examining the interconnections among all the prior studies completed throughout the specified timeframe (Fan et al., 2023). The facilitators highlighted in the literature assist policymakers in formulating the necessary financial innovation strategies to enhance the development of SF. This paper offers a fundamental examination of the research advancements in SF. The research identifies the factors that facilitate the understanding and acquisition of knowledge on the importance of financial innovation and the creation of SF tools for transitioning to a sustainable economy. This information will be valuable for academics, professionals, and policymakers. An examination of prominent academic journals, publications, and other bibliographic sources reveals the trends in research undertaken within a specific topic, aiding in identifying future research directions.

II. Related Research

SF is an emerging discipline within the realm of finance. Economists and international bodies have yet to create a definition or reach a unified agreement. Researchers, organizations, and governments have developed practical and effective definitions. A noteworthy deviation in this matter is that several organizations, instead of defining SF, have introduced the term sustainable banking sector (Nosratabadi et al., 2020). Their tools and methods remain unchanged. A sustainable banking system integrates the cultivation of principles. It facilitates the management of financial resources, enabling natural wealth to fulfill the requirements of an environmentally equitable economy in the long run (Adolat et al., 2024). as defined by the Financial Sustainability Study Group of the G20, refers to the provision of funds to facilitate the widespread adoption of technology that effectively reduces pollution. SF, as defined by the People's Bank of China, is a strategy encompassing various measures and institutions designed to encourage private investment in sectors that promote sustainability and energy efficiency via banking services. SF refers to funding for investments that offer environmental advantages.

The concept of SF diverges from conventional banking methods. This statement highlights the benefits of environmental protection by considering ways of managing environmental risks and the long-term viability of programs. SF aims to support a sustainable economy by funding companies expected to reduce greenhouse gases (Lamb et al., 2022).

The European Banking Federation adopts a comprehensive perspective on climate change by asserting that SF encompasses more than just environmental change-related variables. This approach creates opportunities for developing sustainable insurance programs and securities. Despite their differences, these definitions all have similar aspects, including using resources for a broader and more enduring objective, promoting environmental well-being or minimizing damage to it, mitigating risks to some degree, and establishing rules and infrastructure to maintain the environment. SF is a component of the autonomous banking system that aims to tackle the difficulties presented by global warming and the shift towards a low-carbon economy (García-García et al., 2020). SF refers to financial investments that support activities such as policy-making, insurance/risk remedies, securities, or other business ventures that have a significantly reduced negative effect on the environment compared to the current situation or that actively contribute to beneficial environmental outcomes.

The sustainable economy offers triple advantages. Initially, the advancement of SF enhances the influence of corporate governance aspects, enabling enterprises to achieve a Pareto reduction in the natural environment by transitioning to sustainable industries (Tseng et al., 2021). The sustainable economy fosters environmental consciousness and guarantees that manufacturers and consumers safeguard the environment by embracing sustainable power and employing recyclable, low-carbon goods. SF growth efficiently enhances the framework for production elements, diminishes excess capacity in conventional sectors, and stimulates economic change and advancement.

III. Sustainable Financing Methods

The current investigation has used a bibliometric methodology to comprehend the scholarly output on SF. Bibliometric analysis involves the examination and evaluation of specific literature using a range of statistical and analytical techniques. Following establishing the Science Citation Index (SCI) in 1963, bibliometric evaluation methods have progressed and are now widely recognized for doing meta-analytical research reviews. Web of Sciences and Scopus are the predominant databases that include a substantial portion of academic research.

This work has performed a bibliographic review of critical sources to understand SF's development better. The sample collection for this study has chosen the Scopus records and Web of Science, the most significant abstract and citation repository of peer-reviewed research worldwide. Approximately 84% of the literature in the Web of Science dataset (Birkle et al., 2020) coincides with the Scopus dataset (Herrera-Franco et al., 2020). The chosen dataset utilizes a

more comprehensive comprehension of the previous development of SF. It aids in finding the impactful work conducted over the years.

The data gathering in this study is carried out in four phases: data collecting using appropriate keywords, data cleansing, data formatting, and data analysis using suitable technologies. The study is conducted using a dataset consisting of 650 released publications. These articles were chosen based on strict and methodical criteria for inclusion and exclusion. The research used the methods employed for the bibliometric evaluation of SF.

The study emphasizes funding the sustainable transition via specific tools. Hence, terms like clean money and investment were not included. The research consists of papers on SF that analyze the environmental and global warming dimensions and delve into sustainable bonds. The data has undergone filtration based on language, resulting in the selection of articles written in English. To select solely peer-reviewed publications, publications and reviews were considered based on their document format. In the last stage, each item was carefully assessed, and any articles that were not relevant were removed. The papers were removed based on an evaluation of their abstracts. The documents that fell beyond the parameters of the research were eliminated. Figure 1 illustrates the structure of the data-collecting architecture.

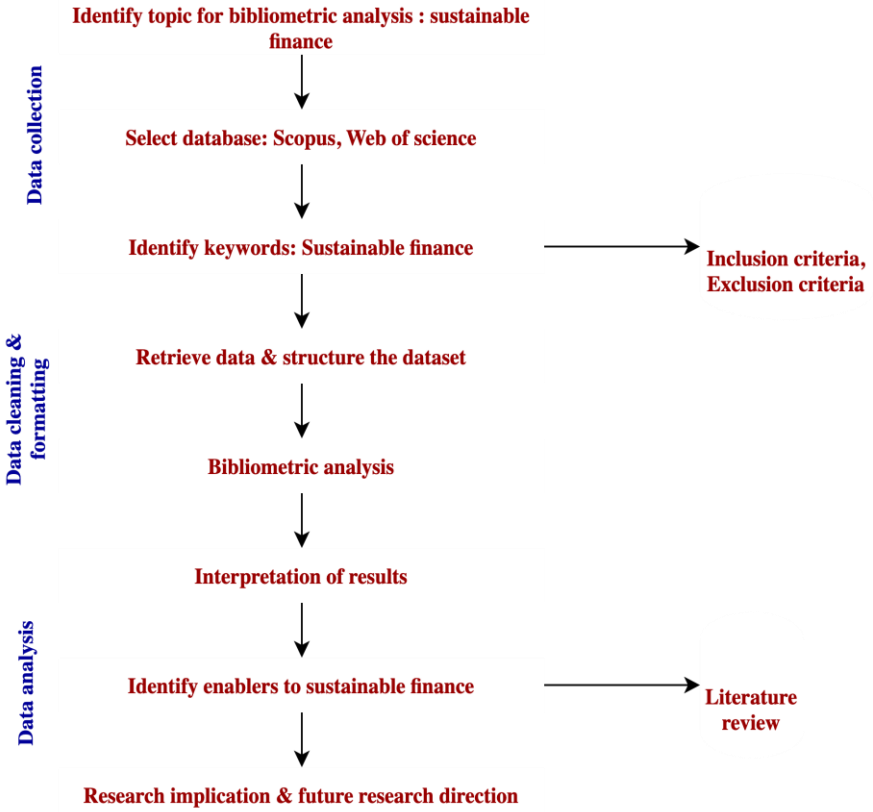

Fig. 1 Workflow of the Bibliometric Analysis

Following applying the rules for inclusion and exclusion, a dataset including 650 papers out of the initial 1260 articles was selected for additional analysis. The bibliographic evaluation is performed using Bibliometrix, a statistical software tool accessible via R-studio and Viewer. Both software programs facilitate the retrieval of pertinent bibliometric data, including information on leading authors, references, evaluation of keywords, and top nations of production. The research covers the period from 1995 to March 2024. A more extended period facilitates the examination of the development of the notion. The viewer provides a graphical representation of the database, making it straightforward to comprehend enormous amounts of information. The software has a solid and user-friendly graphical interface that facilitates the analysis and interpretation of bibliometric mapping.

The facilitators of SF have been found by an extensive examination of the research published between 2017 and March 2024. The reason for choosing this particular time frame is that over 60% of the material examined was released during that time. Several established and developing nations have actively engaged in academic programs to protect the climate and ecology.

IV. Results and Discussions

As a technical and scientific assessment instrument, Bibliometrics offers a range of qualitative and quantitative indices to evaluate scientific and technological advances.

Bibliometrics is primarily employed for analyzing scientific papers, evaluating scientific studies, assessing subject growth, and evaluating organizations.

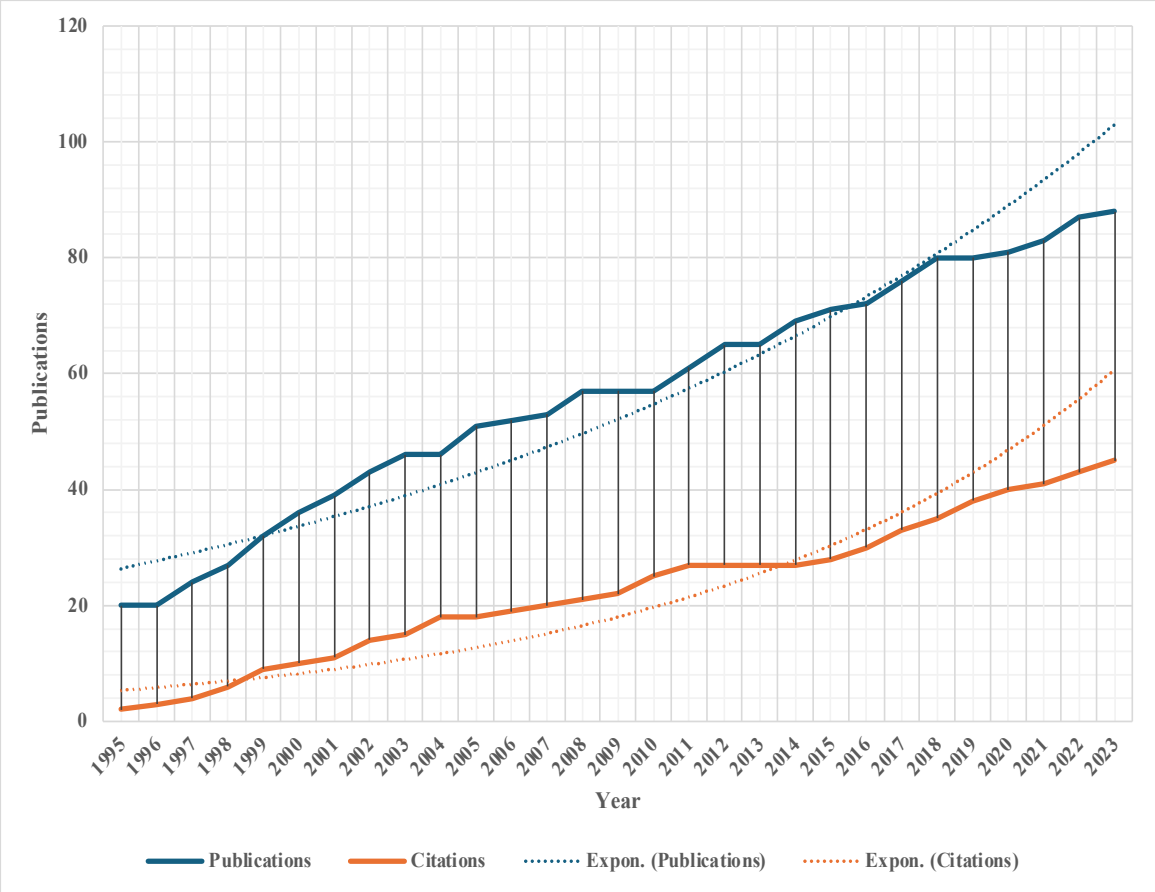

Fig. 2 Publication and Citation Analysis

The publishing data provide insights into the research patterns within a specific topic, while the citation numbers measure the impact or influence of that field. Figure 2 displays the publication and citation counts of financial sustainability and policy regarding energy from 1995 to 2023. The research sees a general upward trend in articles and references. The data for 2023 is significantly lower because the numbers only include part of the year. The examination of the publication count indicates that the number of articles between 2009 and 2012 is below 20. Currently, SF is not a prominent area of study. Between 2013 and 2021, the field of SF had a notable increase in research activity. In 2013, a turning point was a substantial surge followed by a slight decrease. Since 2023, SF studies have grown significantly, with an annual publication rate of over 80 papers.

Based on the citation count, it can be inferred that the number of references in SF studies has steadily risen each year. Between 2010 and 2023, the number of references has increased by almost 900-fold, demonstrating a significant and ongoing growth in research interest in SF. The research gets two lines of trend by plotting the curve of the number of articles against the number of references. The correlation coefficients of the two trend lines are 0.89 and 0.91, respectively. The trend line indicates a rising exponential pattern, providing evidence that the study area of SF and policy regarding energy has transitioned from the initial stage to a phase of fast development.

Multiple nations are making substantial contributions to the field of SF study. This section focuses on the most productive nations from 1995 to 2023. Figure 3 displays the outcomes of the top 10 nations that publish research on SF. The number of articles determines the ranking.

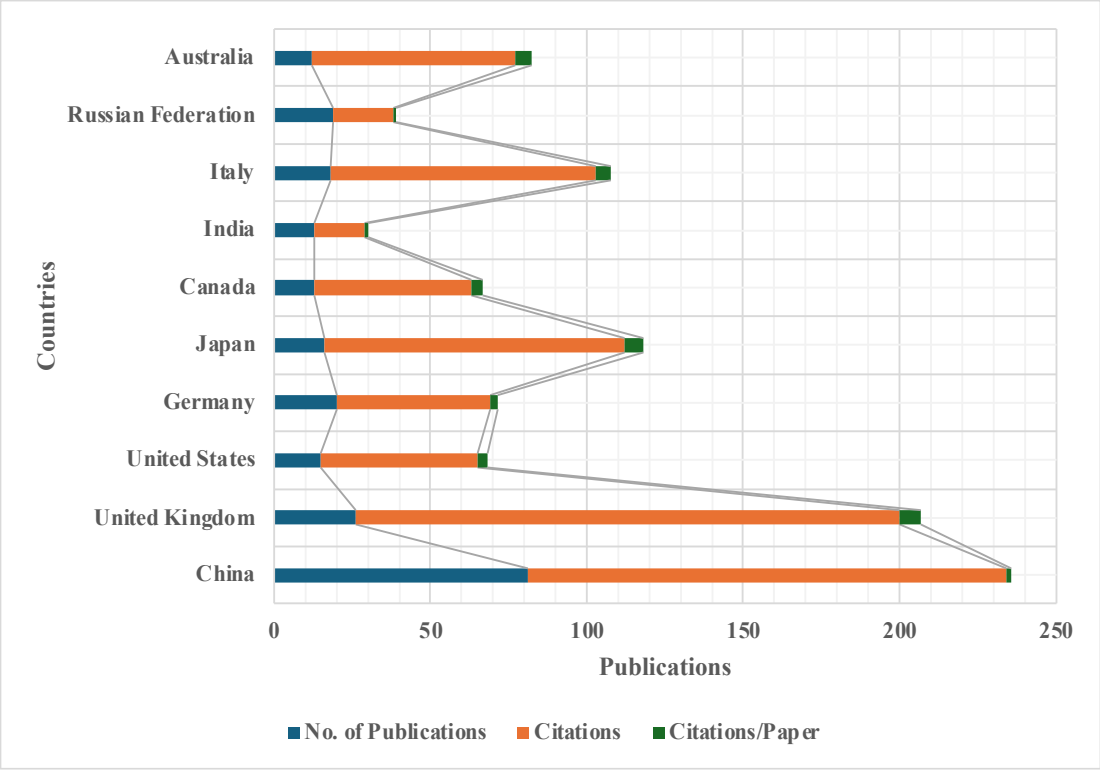

Fig. 3 Publication Analysis of Different Countries

According to the data, China has the most productivity across countries, with 75 articles. This suggests that Chinese scholars are the most focused on SF compared to other scholars. The United Kingdom is second, with 17 journals, while the United States follows closely with 18 journals. China is not the only Asian nation in the ranking chart. Japan and India have made notable advancements in SF studies, with 12 and 8 publications, respectively.

A bibliometric coupling is constructed to enhance comprehension of the interconnections across nations that publish research on SF. Bibliographic coupling occurs when a third study is extensively cited in two papers. Regarding countries, cross-referencing happens when a publication from two distinct nations cites a third source in their research papers, illustrating how nations include relevant material in their publications.

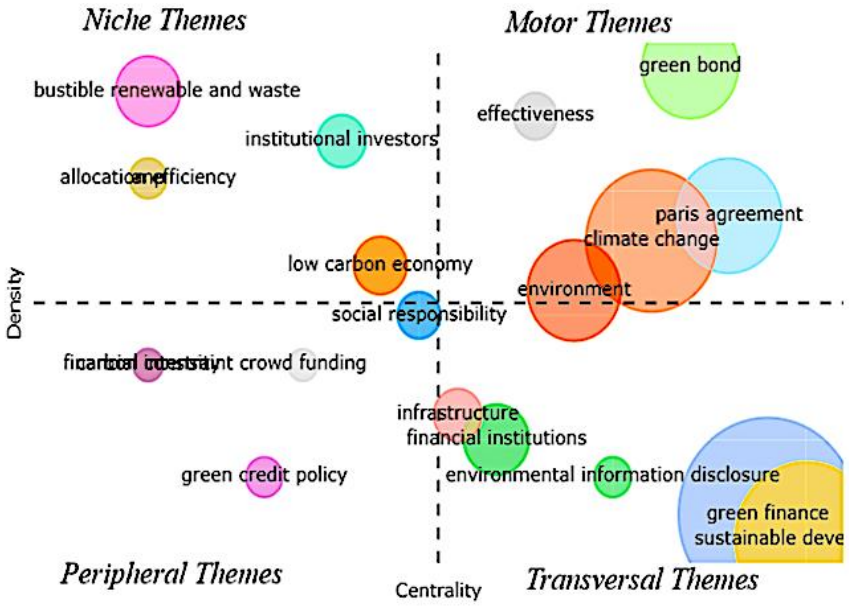

Fig. 4 Thematic Map Analysis

To create a thematic map (Figure 4) displaying the keywords related to SF, the research utilized the Biblioshiny module of Studio. The minimum regularity required for a term included in the map was five occurrences per thousand phrases. This method facilitates identifying and representing the primary topics addressed in the publication. As suggested, the provided map organized the primary themes into four categories based on the density and importance ratings along the X and Y axes. The significance is a metric that quantifies the level of connectivity between a network and other systems. It represents the significance of an issue, such as SF, within the broader research context. When comparing, density measures the level of development of topics depending on the network's inherent strengths.

- Motor subject

The subjects in the journal are well explored and provide the essential framework of the study. These themes exhibit a significant level of centrality and concentration. This quadrant encompasses warming temperatures, the Paris Agreement, efficacy, sustainable bonds, and environmental issues. These statistics indicate that the journal primarily focuses on study topics related to ecological and worldwide climate challenges. An exceptionally advanced concept explored in the magazine is sustainable bonding.

- Niche subject

Niche themes refer to highly focused and extensively researched topics within a particular academic field or publication. The journal focuses on three specific study topics: financial institutions, allocation effectiveness, and the economy with a low carbon footprint. These fields are well-developed and specialized. The most often used ideas are combustible, recyclable, and trash.

- Peripheral subject

The third quadrant encompasses the topics developing or diminishing in the journal. These topics exhibit both low centralization and low concentration. This quadrant covers social responsibility, fundraising, SF policies, the financial sector, and carbon intensity. It should be noted that these domains intersect in the accompanying graphic. Social duty is becoming more critical and universally significant than the other regions in the magazine.

- Transversal subject

The fourth region is defined by its low population density and high level of centrality. These topics are crucial for the study, yet their development still needs to be improved. Issues like SF and equitable growth are distant from the central and peripheral topics. The themes in this sector have less content but a greater centrality than the other issues.

The research outlines four viable strategies in SF: the carbon taxation policy, government assistance regulations, sustainable bond regulations, and environmentally friendly investment strategy. Here is a comprehensive analysis:

1) Policy regarding the imposition of a fee on carbon emissions. Implementing a policy that lowers the release of greenhouse gases, raises the financial burden of burning petroleum and coal for businesses, and promotes the use of clean energy and the production of sustainable goods is an efficient approach. Conduct extensive and reliable surveys to examine the French perspective on carbon taxes and other green initiatives to assess the impact of implementing carbon tax legislation.
2) Policy on government subsidies. It is fundamentally a method of providing financial aid. By providing financial support to companies engaged in environmentally friendly study and creation and enhancing the sustainability of their goods, the research can promote sustainable development and reduce carbon emissions. The researchers examine the past subsidy policies used by the Chinese government to ascertain the most effective subsidy plan, taking into account both producer rivalry for prices and the product's green credentials.
3) Policy for sustainable bonds. Sustainable bonds have emerged as a significant tool for exploring financial sustainability, making them a prominent and much-discussed subject in recent years. Some researchers have conducted experimental and event research to examine the impact of issuing sustainable bonds on the stockholders, the price of sustainable securities in the financial marketplace, and the link to ecological preferences.
4) Policy for investing in sustainable practices. It is a method of promoting the growth of sustainable technologies. Robust and cohesive policies can attract and retain investment within a particular nation. The Czech Republic presents its sustainable investing strategy. A SF plan also considers investments in renewable energy and efforts to increase energy effectiveness. They saw the blockchain as a potential tool for supporting sustainable projects in social fundraising.

V. Conclusion and Findings

SF and energy strategy studies have gained significant attention in recent years. While the quantity of studies and references in this discipline has seen considerable growth, a comprehensive analysis of how research works in this sector needs to be done. This research uses bibliometric analysis to organize and evaluate the literature on SF and energy policies. This study conducts a statistical description of a total of 650 publications. The analysis includes examining the general growth, publishing sources, research nations and regions, and high-level research institutes. The research analyzes clusters, explicitly focusing on co-cited article evaluation, author clustering, and the dynamic trends in SF and policy regarding energy research. Based on the study, the research has reached the following conclusions.

1) The field of SF policy has seen significant growth during the last two years. The current annual publication count surpasses 80, indicating substantial interest in SF and energy policy studies.
2) By conducting descriptive statistical analyses, the research has identified several prominent academic institutions specializing in SF and policy regarding energy.
3) The research findings of the co-cited authors suggest that academics are aware that globalization is interconnected with environmental preservation and equitable growth. Prior research has examined critical issues in SF and power policy and potential solutions from an international viewpoint, such as global collaboration in safeguarding the environment.
4) Through the clustering evaluation of research, the research has identified four viable options in SF planning: taxing carbon policy, government subsidy regulations, sustainable bonding regulations, and sustainable investing strategy. The government employs a carbon tax policy to raise the price of burning petroleum and coal for businesses while also using government subsidy policies to encourage the creation and advancement of sustainable technologies. Implementing sustainable bond legislation offers a viable solution to address the financial challenges associated with sustainable projects. For example, several emerging electric vehicle companies are attempting to issue sustainability bonds to secure finance and stimulate the manufacturing of electric vehicles. The SF approach prioritizes the development of sustainable facilities, namely dam and solar photovoltaic generation.

The research has identified the prominent concerns discussed in recent years by evaluating this work regarding time zones. The research has examined the potential areas for future study. Current topics of interest include sustainable securities, carbon dioxide greenhouse gases, sustainable contradictions, and government support, focusing on sustainable securities. Exploring feasible and sustainable policies is a potential area of future study in energy policy.

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