

Bibliometric Computational Mapping Analysis of Publications on Green Finance and Financial Technology Using Vosviewer

Muhamad Syahwildan¹, Muhamad Fajrinur²

^{1,2}Pelita Bangsa University

Abstract

This study uses a bibliometric method together with computational mapping analysis conducted with VOSviewer to look at the growth of research on green finance and financial technology. The Google Scholar database was used to get article data, which was then entered into the publish or perish reference management program. By using the keywords "Green Financial Technology", "Green Finance", "Financial Technology", and "Green FinTech", article titles and abstracts are utilized to direct the search process. 989 items were discovered and deemed relevant. The research period covered by the study material is the last five years' worth of Google Scholar-indexed publications (2018 to 2022). The study's findings indicate that three terms green finance, financial technology, and fintech – can be used to categorize research on green finance technology. With a strength of 1802 connections, the phrase "Green finance" has 191 links. The terms "Financial technology" and "Fintech" each have 197 and 186 links, respectively, totaling 2046 and 1121 links. The research of the growth of financial technology and green publications over the last five years revealed some noteworthy trends. Between 2018 and 2020, there was a rise from 99 in 2018 to 243 in 2020, however from 2020 to 2022, there was a decline in research. In contrast, 243 investigations on well-known green financial technologies were conducted in 2020. Using VOSviewer, we counted the number of articles that have been written regarding green financial technology and how it relates to green finance. This review may serve as the basis for further investigation into other subjects, such as green fintech.

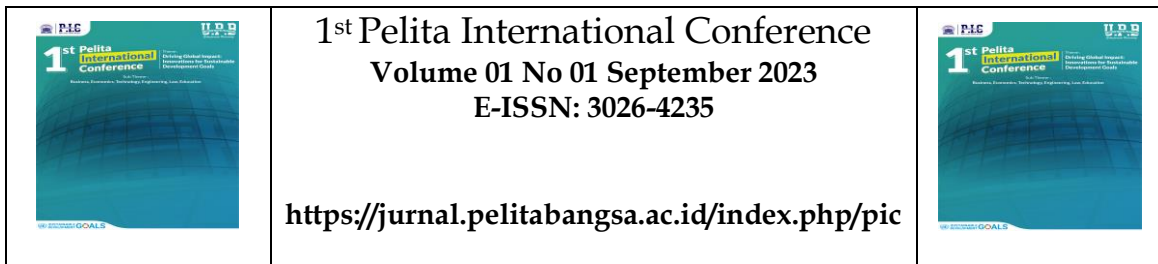
Keywords: Bibliometrics, Green Fintech, Green Finance, Financial Technology, Fintech

INTRODUCTION

The concept of sustainability finance or finance related to the environment has become increasingly important over the last few years. Even the Paris Agreement and the achievement of the Sustainable Development Goals (SDGs) require a significant investment of at least \$3 trillion per year globally and \$1.4 trillion in developing countries (Schmidt-Traub, 2015; Schmidt-Traub & Sachs, 2015). This awareness of the importance of the environment has brought many companies in various countries involved in the environment, investment and social performance and governance (ESG).

In order to combine technology and finance to accomplish sustainable development goals, the idea of green financial technology first developed. A financial technology idea known as "green financial technology" focuses on green finance that encourages green investment. Green financial technology also makes it possible to stimulate economic growth, which lowers social inequality, poverty, and environmental destruction. In essence, more green financial technology is required to address global warming and mitigate its repercussions (Mulay, 2018). Green finance systems can monitor and choose green initiatives, help financial intermediaries, and quantify their environmental impact. (Yang et al., 2020)

Given the popularity of green finance and FinTech among practitioners, the theme of green finance and FinTech has also become a hot topic in academic research. There are several studies that discuss green financial technology, one of which was conducted by (D. Zhang et al., 2019) where they conducted a bibliometric analysis of green finance. Another study conducted by (J. Zhang, 2022) provides an example of a Fintech company from China, namely Ant Forest, which focuses on green financing. Several other studies have been conducted including research on how green fintech can reduce the impact of climate



change (Puschmann et al., 2020), research on green fintech (Blakstad & Allen, 2018), green fintech research on bitcoin sustainability (Kabaklarlı, 2022), research on digital wallets in supporting the sustainability of green financial technology (Anshari et al., 2021), and research on the role of green financial technology for Singapore (Tao & Azhgaliyeva, 2018).

However, even though a lot of research discusses Green Finance and Financial technology, surprisingly there is still little literature that specifically discusses green fintech. Therefore, to explore and develop studies on green fintech, this paper will combine green finance and financial technology using a computational bibliometric mapping analysis approach. In particular, bibliometric analysis involving research studies in the last five years, namely between 2018 and 2022, using the VOSviewer application, has also not been widely carried out.

Therefore, the purpose of this research is to conduct a computational study that uses bibliometric analysis to map indexed articles on Google Scholar, using VOSviewer software. This study aims to provide a reference for researchers in determining and exploring research themes, especially those related to the field of green financial technology.

RESEARCH METHOD

Articles from journals that have been indexed by Google Scholar are the source of article data for this investigation. The decision to use an open source database led to the choice of Google Scholar as a research data source. We use a reference management tool called Publish or Perish to get research data. To conduct a literature review on our chosen subject, the Publish or Perish program was used. Research by Al Husaeni et al. (Al Husaeni & Nandiyanto, 2022) provide detailed information on the use and installation of this software and the procedures used to obtain data, and the research of Azizah et al. previously (Azizah et al., 2021) provided detailed information about library search used to search data on Google Scholar.

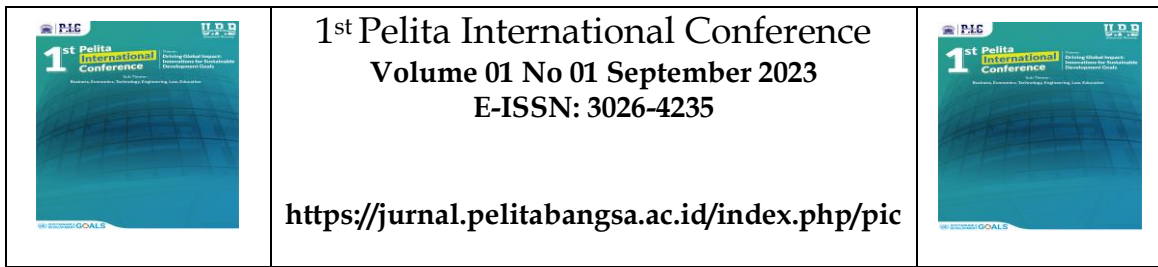
The research was conducted through several stages collection of publication data using the publish or perish application, bibliometric data processing for articles that have been obtained using the microsoft excel application, computational mapping analysis of bibliometric publication data using the vosviewer application, and analysis of computational mapping analysis results.

Filtering articles using the terms "Green Financial Technology", "Green Finance", "Financial Technology", and "Green FinTech" is done by searching for article data using the Publish or Perish tool. The research articles utilized in this study were released between the years of 2018 and 2022. All information was gathered in June 2023. The research information system file format (.ris) and the comma separated value format (*.csv) were used to export the articles that met the criteria for selection and that met the research analysis criteria. Additionally, article data from database sources was mapped using the VOSviewer program. Three different types of publishing mapping, including network visualization, density visualization, and network-based overlay visualization (co-citation between existing elements), were created using VOSviewer. 989 searches totalling data processing for bibliometric analysis utilizing the mapping visualization of VOSviewer obtained from the Google Scholar database.

RESULTS AND DISCUSSIONS

Publication data search results

A total of 989 data articles that meet the research requirements were collected based on data monitoring using a published or perish reference management program from the Google Scholar database. This information is in the form of article metadata, which includes the author's name, article link, year of publication, journal name, publisher, number of citations, and related URLs. In a VOSviewer check of this study, some published data samples are shown in Table 2. The top 20 publications with the most citations



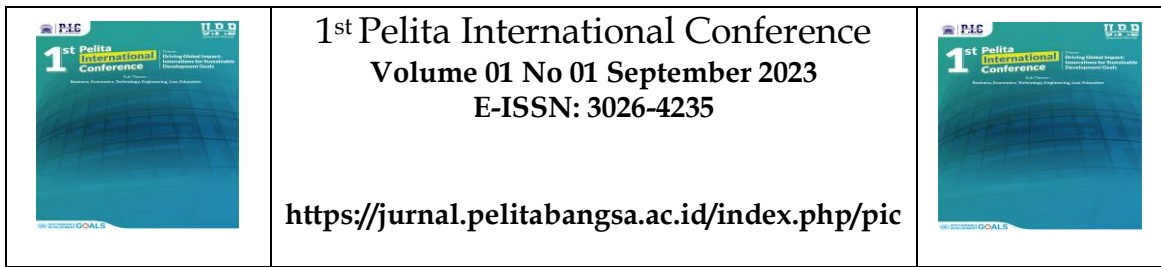
were used as sample data. All publications used in this analysis received 24451 citations, with an average of 4890 citations each year. The average number of authors in the papers used was 2.53, there were 24.72 citations for each article, and all articles had an average h-index of 71 and a g-index of 111.

Table 1. Research Matrix

Publication Years	2018-2022
Citation years	5(2018-2019)
Papers	989
Citation	24451
Cites/year	4890,2
Cites/paper	24,72
Author/paper	2,53
h-index	71
g-index	111

Table 2. Publication Data of Green Finance and Finance Technology

NO	Authors	Title	Year	Cites	Refs
1	F Taghizadeh-Hesary, N Yoshino	The way to induce private participation in green finance and investment	2019	412	(Taghizadeh-Hesary & Yoshino, 2019)
2	D Zhang, M Mohsin, AK Rasheed, Y Chang...	Public spending and green economic growth in BRI region: mediating role of green finance	2021	384	(D. Zhang et al., 2021)
3	K Leong, A Sung	FinTech (Financial Technology): what is it and how to use technologies to create business value in fintech way?	2018	364	(Leong & Sung, 2018)
4	D Zhang, Z Zhang, S Managi	A bibliometric analysis on green finance: Current status, development, and future directions	2019	330	(D. Zhang et al., 2019)
5	CH Yu, X Wu, D Zhang, S Chen, J Zhao	Demand for green finance: Resolving financing constraints on green innovation in China	2021	309	(Yu et al., 2021)
6	CC Lee, CC Lee	How does green finance affect green total factor productivity? Evidence from China	2022	305	(Lee & Lee, 2022)
7	S Dikau, U Volz	Central bank mandates, sustainability objectives and the promotion of green finance	2021	280	(Dikau & Volz, 2021)
8	X Zhou, X Tang, R Zhang	Impact of green finance on economic development and environmental quality: a study based on provincial panel data from China	2020	232	(Zhou et al., 2020)
9	DHB Phan, PK Narayan, RE Rahman...	Do financial technology firms influence bank performance?	2020	221	(Phan et al., 2020)
10	JD Sachs, WT Woo, N Yoshino...	Importance of green finance for achieving sustainable development goals and energy security	2019	220	(Sachs et al., 2019)
11	M Ansori	Perkembangan dan dampak financial technology (fintech) terhadap industri keuangan syariah di Jawa Tengah	2019	216	(Ansori, 2019)



12	MA Nawaz, U Seshadri, P Kumar, R Aqdas...	Nexus between green finance and climate change mitigation in N-11 and BRICS countries: empirical estimation through difference in differences (DID) ...	2021	205	(Nawaz et al., 2021)
13	X Ren, Q Shao, R Zhong	Nexus between green finance, non-fossil energy use, and carbon intensity: Empirical evidence from China based on a vector error correction model	2020	204	(Ren et al., 2020)
14	M Palmié, J Wincen, V Parida, U Caglar	The evolution of the financial technology ecosystem: An introduction and agenda for future research on disruptive innovations in ecosystems	2020	192	(Palmié et al., 2020)
15	S Zhang, Z Wu, Y Wang, Y Hao	Fostering green development with green finance: An empirical study on the environmental effect of green credit policy in China	2021	181	(S. Zhang et al., 2021)
16	MS Meo, MZ Abd Karim	The role of green finance in reducing CO2 emissions: An empirical analysis	2022	174	(Saeed Meo & Karim, 2022)
17	T Muganyi, L Yan, H Sun	Green finance, fintech and environmental protection: Evidence from China	2021	169	(Muganyi et al., 2021)
18	M Irfan, A Razzaq, A Sharif, X Yang	Influence mechanism between green finance and green innovation: Exploring regional policy intervention effects in China	2022	163	(Irfan et al., 2022)
19	S Dikau, U Volz	Central banking, climate change and green finance	2018	155	(Dikau & Volz, 2019)
20	S Hafner, A Jones, A Anger-Kraavi, J Pohl	Closing the green finance gap–A systems perspective	2020	147	(Hafner et al., 2020)

Development of research in the field of Green Fintech

Table 3 lists the latest research findings in the field of Green Financial Technology that have been published in journals indexed by Google Scholar. Based on the information in Table 3, it is clear that 989 papers in the subject of green financial technology were published between 2018 and 2022. Ninety-nine articles were published in 2018, 181 articles in 2019, 243 articles in 2020, 239 articles in 2021, and 225 articles in 2022. According to the number of publications, research on green financial technology tends to grow every year, especially in the last five years (2018–2022), although it has slightly decreased in the previous two years. In Figure 1, you can see how it's progressing.

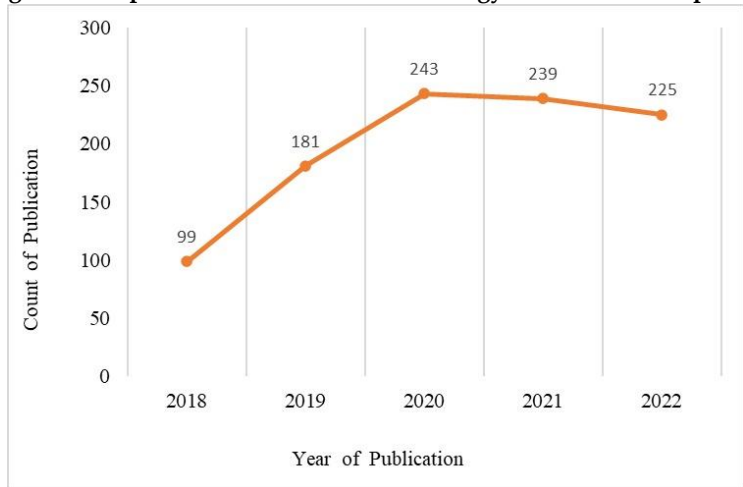
Figure 1 shows the development of Green Financial Technology research over the last 5 years in the range from 2018 to 2022. Based on Figure 1 it is known that research developments related to Green Financial Technology have experienced a slight decline from 2020–2022. This decrease can be seen from the number of publications in 2020 of 243 to 2022 of only 225 publications. Previously, the development of Green Finance Technology research experienced a significant increase in 2018–2020.

Table 3. Development of Green Financial Technology Research

<u>Year of Publication</u>	<u>Count of Publication</u>
2018	99
2019	181
2020	243
2021	239
2022	225

Average	197,4
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Figure 1. Graph of Green Financial Technology Research Development



Visualization of Green Finance and Financial technology topic areas using VOSviewer

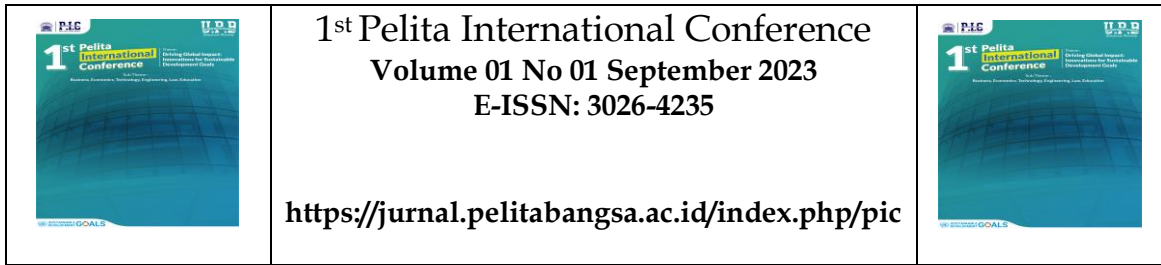
The data from the paper is subjected to computational mapping. Computational mapping makes use of VOSviewer. 227 objects were discovered from the computational mapping findings. The data mapping breaks down each item connected to green finance and financial technology into 8 groupings, including:

Cluster 1 has 48 items and are marked in red, the 48 items are aspect, carbon emission, change, china, city, climate change, construction, country, data, development, economic development, economic growth, efficiency, empirical analysis, empirical evidence , enterprise, environment, environmental pollution, environmental protection, evaluation, evidence, green credit, green economy, green finance, green finance development, green finance index, green finance policy, green finance reform, high quality economic development, impact, implication, innovation , machanism, model, nexus, paper, perspective, pilot zone, policy, progress, province, quality, relationship, role, sustainability, sustainable development, transformation, upgrading.

Cluster 2 has 42 items and is marked in green, 42 of these items are abstract, access, africa, bank, banking, banking services, behavior, benefits, business, cost, determinant, ease, effort, factor, financial inclusion, financial institution, financial service, financial technology, financial technology adoption, financial technology innovation, financial technology service, financial technology system, fintech, green development, growth, intention, Islamic banking, Islamic financial technology, medium enterprise, nigeria, perception, person, problem, prospect , small, sme, smes, society, study, swot analysis, use, and user.

Cluster 3 has 30 items and is marked in blue, the 30 items are approach, article, banking industry, barrier, bibliometric analysis, climate, concept, disruptive innovation, economy, emergence, evolution, example, fact, financial industry, fintech company, industry, interest, pakistan, paris agreement, payment, period, product, recent year, rise, sector, solution, strategy, theory, time, and understanding.

Cluster 4 has 25 items and is marked in yellow, the 25 items are addition, application, area, bangladesh, blockchain, case study, challenge, chapter, demand, field, finance, financial system, focus, future, green finance market, green fintech, issue, opportunity, order, overview, situation, system, technology, term, and trend.



Cluster 5 has 23 items and is marked in purple, the 23 items are analysis, context, financial technology peer, green bond, implementation, Indonesia, Islamic finance, legal protection, lending, literature, malaysia, need, p2p, peer, peer lending , practice, rapid development, regulation, review, sharia financial technology, survey, type, and world.

Cluster 6 has 22 items and is marked with sky blue, the 22 items are the banking sector, case, consumer, covid, effectiveness, energy efficiency, era, existence, financial sector, financial technology company, financing, green finance system, increase, investment, operation, pandemic, process, renewable energy, renewable energy investment, risk, road initiatives, and sustainable development. Cluster 7 has 22 items and is marked in orange, the 22 items are application, artificial intelligence, driver, environment, evolution, fintech model, fintech solution, growth, hand, highlight, information technology, internet, iot, organization, part, sdgs , smes, solution, strategy, sustainable development, thing, trend.

Cluster 7 has 20 items and is colored orange, the 20 items are Acceptance, adoption, artificial intelligence, attention, big data, combination, customer, entropy method, financial technology firm, financial technology industry, india, information, information technology, market, money, new technology, poverty, service, way, and year.

Cluster 8 has 17 items and is colored brown, the 17 items are company, driver, effect, empirical study, environmental performance, environmental regulation, financial behavior, financial literacy, financial performance, firm, green innovation, influence, level, performance, research , sample, and significant effect.

Each cluster shows how one phrase is related to another. Each phrase is labeled with a colored circle next to it. Depending on how often a tribe appears, the circle size for each tribe fluctuates (A. B. D. Nandiyanto et al., 2021). Circle label size correlates well with the use of phrases in abstracts and titles (A. Nandiyanto & Al Husaeni, 2021).. Label size increases with word frequency (Al Husaeni & Nandiyanto, 2022). Network visualization (see Figure 2), density visualization (see Figure 3), and overlay visualization (see Figure 4) are the three components of mapping visualization studied in this study (Hamidah et al., 2020).

Figure 2. Network visualization of Green Finance and financial technology

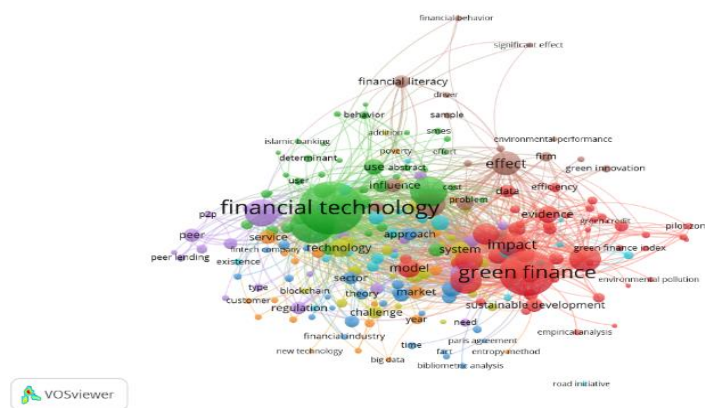


Figure 3. Overlay Visualization of Green Finance and Financial Technology

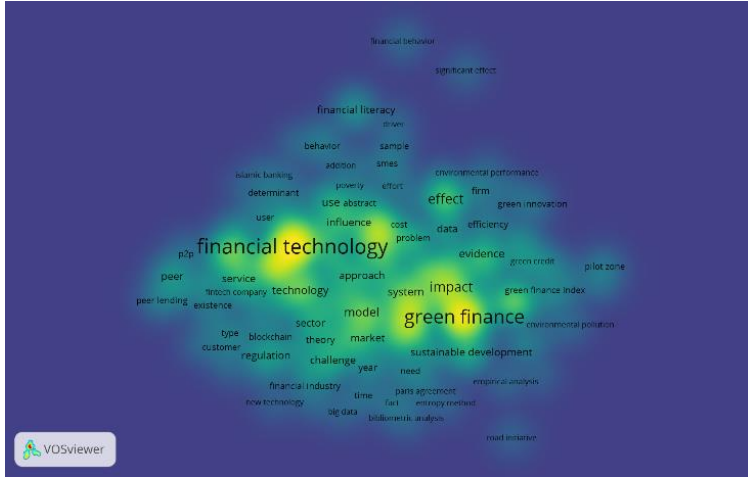


Figure 4. Density Visualization of Green Finance and Financial Technology

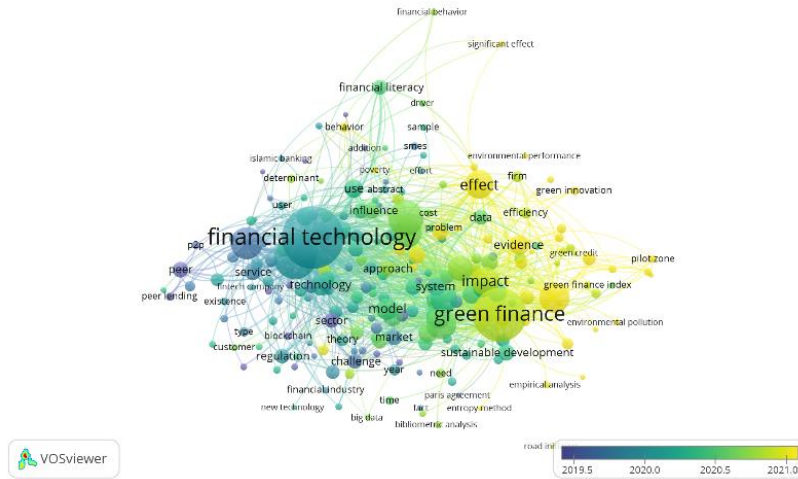
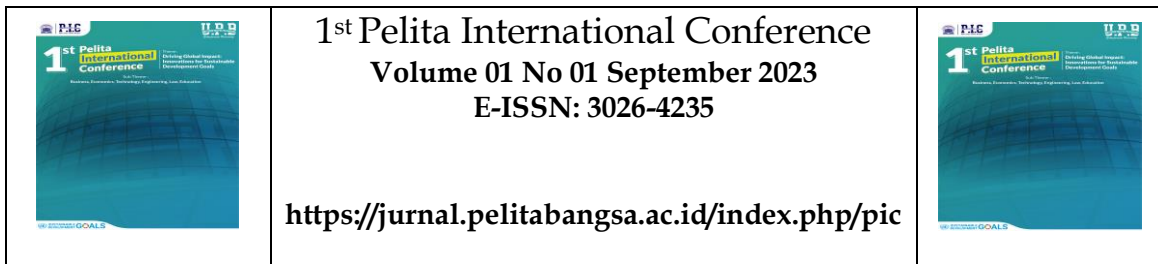


Figure 5. Network visualization of Green Finance

The interrelationships between concepts can be seen in Figure 2. An interconnected network is used to describe the relationships between concepts. Clusters of each phrase that are often studied and associated with the subject of financial technology and green finance studies are shown in Figure 2. According to the network visualization cluster, research on green finance and financial technology can be separated into three categories. For example, cluster 1 cluster 1 has the word "green finance," which has a total of 191 linkages, an overall link strength of 1802, and 352 events. (Note 5 in Figure). The second term is financial technology which is included in group 2 with a total of 186 links, a total of 1121 link strengths, and 224 events (see Figure 7). It has a total of 197 links, a total strength of 2046 links, and 457 occurrences. (see figure 6)



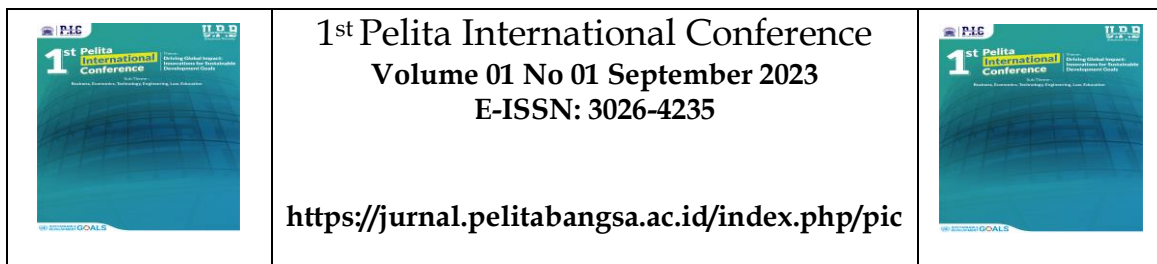
The depiction of density is shown in Figure 3. Based on density visualization, the phrase will appear more often, the brighter the yellow color and the larger the diameter of the term label circle (Mulyawati & Ramadhan, 2021; A. Nandiyanto & Al Husaeni, 2021; A. B. D. Nandiyanto et al., 2021). This shows that many studies have been conducted on related topics. Likewise, if the term color is less distinct from the background color, fewer studies have been conducted. According to Figure 3, there are many studies related to Green Finance, Financial technology, Fintech, technology and research.

Figure 4 shows an overlay visualization on green financial technology research. This visualization overlay demonstrates the novelty of research on related terms (Al Husaeni & Nandiyanto, 2022; Hamidah et al., 2020; A. Nandiyanto & Al Husaeni, 2021; A. B. D. Nandiyanto et al., 2021).. Figure 4 shows that the most research on financial technology is carried out in 2019 to 2020. Meanwhile, research on green finance is mostly carried out in the period 2020 to 2021. This shows that research related to financial technology has opportunities for renewal. Thus, we can easily make new research on financial technology.

Figure 5 shows the green finance relationship network with other terms, namely impact, paper, financial technology, technology, fintech, approach, study, china, role, country, evidence, data, research, sustainability, sustainability development, energy efficiency, covid, green finance policy, effect, growth system, model, firm, regulation, innovative, etc. Figure 6 shows the network of relationships between financial technology and existing terms, including green finance, technology, sector, lending, peer, effect, impat, model, firm, use, determinant, financial literacy, Islamic banking, blockchain, artificial intelligence, fintech, financial industry, payment, covid, efficiency, data, etc. Whereas Figure 7 shows the network of relationships between fintech, which is associated with the terms, financial literacy, financial technology, green finance, impact, effect, lending, factor, regulation, challenge, evidence, technology, approach, service, model, sector, blockchain, study , covid, influence, behavior, china, Indonesia, role, etc.

Figure 8 shows that green fintech still intersects with other concepts. Green finance has only 32 links in the chain and is linked to 6 events, according to mapping data. Fintech and financial technology, in contrast to green finance, are often used interchangeably and are considered to have significant significance. Based on these findings, it can be said that there is still a strong possibility that the subject of green fintech will be studied and associated with other concepts, which will have a greater impact on research novelty.

Based on the results of the collected article data mapping, it appears that the keyword green fintech is still rarely used in research. Most of the research only uses terms or fields related to green finance, financial technology and fintech. From the results of this study, research on green fintech that is newer and up to date can be sought.



Mapping Bibliometric Analysis in the topic area of Green Finance and Financial technology using VOSviewer

Bibliometric analysis mapping was carried out using the VOSviewer application. Several conditions were carried out, namely the minimum value of the appearance of the term was 2 times so that 44 terms were found. Figure 9 shows a network visualization between terms. Network visualization shows the connectedness between terms (Husaeni & Nandiyanto, 2022). The circle in the picture is a knot. This node describes a term contained in green finance and financial technology (Husaeni & Husaeni, 2022).. Based on the case in Figure 9, it is known that the size of the color nodes indicates the number of occurrences of a term (i.e. the number of times the keyword appears (A. B. D. Nandiyanto et al., 2021).. The larger the circle of a term, the higher the number of occurrences, and the thicker the connection between nodes, the greater the total strength link between the terms (Al Husaeni & Nandiyanto, 2022).

Figure 9. Network Visualization between terms

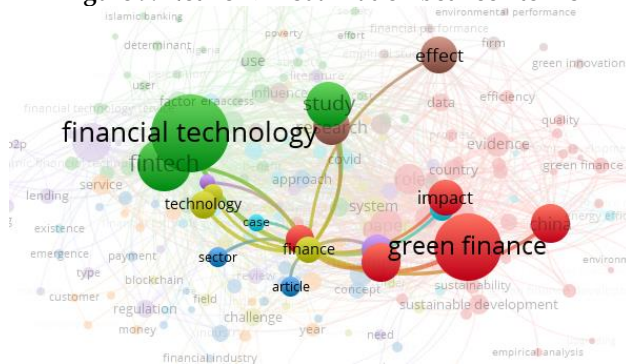


Figure 10 shows the relationship between the terms green finance and financial technology. Based on this figure, the strength of the linkage between the terms green finance and financial technology is 5. Figure 11 shows the linkage between the terms green finance and fintech with a link strength value of 10. And figure 12 shows that green fintech has no relation to any term so it has no link strength value. The strength of the relationship shows the strength of the relationship between the two terms, the higher the value indicates the stronger the relationship between the two terms (Derrick et al., 2014). Based on the link strength value, the connectedness of the terms green finance and fintech is stronger when compared to the connectedness of green finance and financial technology. This means that more researchers are linking green finance and fintech research. Meanwhile, the term green fintech has no relation to green finance or financial technology.

Figure 10. Corelation between green finance and financial technology

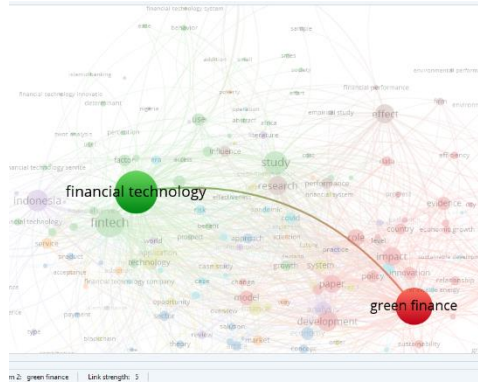
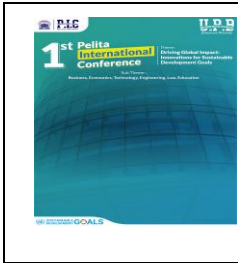


Figure 11. Correlation between green finance and fintech

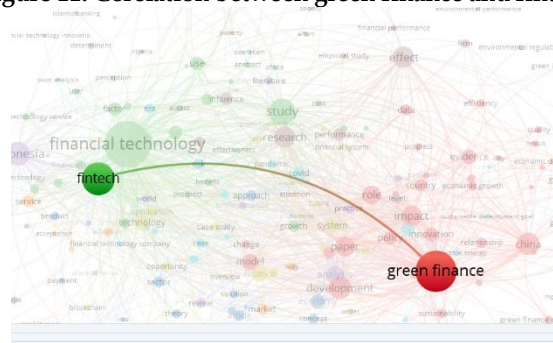
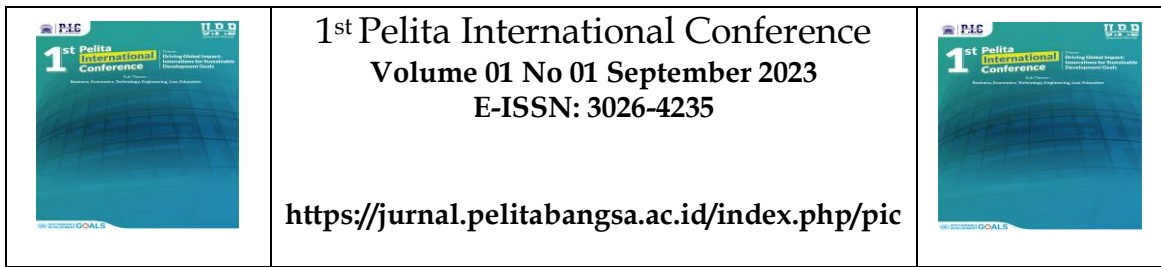


Figure 12. Green fintech terms that are not associated with other terms



CONCLUSION

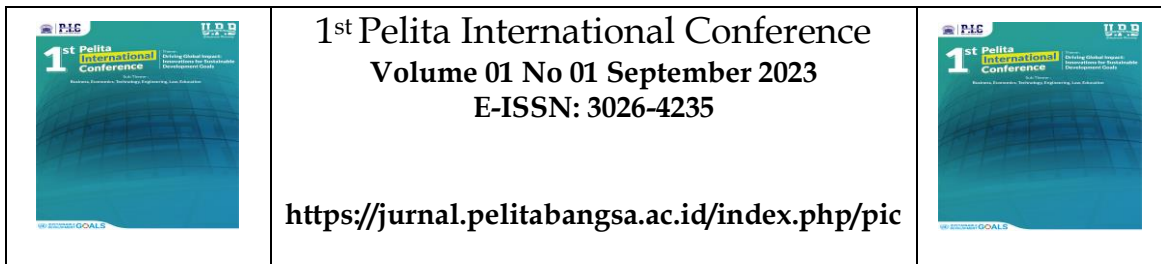
Computational mapping analysis of published research bibliometric data is the aim of this study. The term "financial technology and green finance" refers to the publishing subject chosen for this study. The papers used were obtained from Publish or Perish from the Google Scholar database. Title and abstract



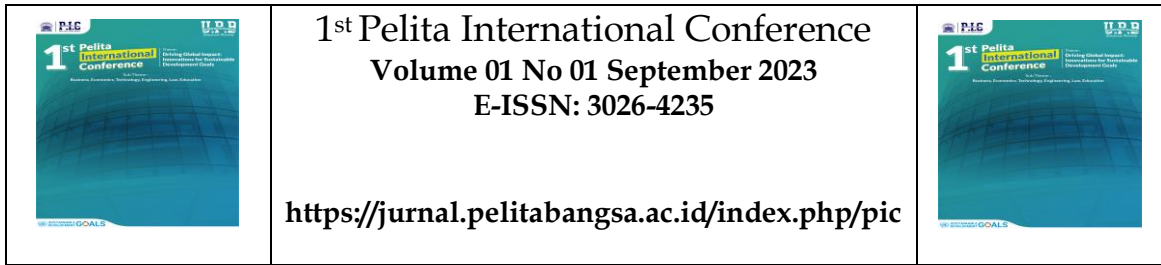
are one of the library information used in this study. 989 related articles were published between 2018 and 2022, according to search results. The findings reveal that research on green financial technology increased significantly between 2018 and 2020 and then decreased somewhat between 2020 and 2022. The research findings suggest that there are still many opportunities for research in green fintech, which are also related to other topics. In addition, further research is still needed on the phrase "financial technology".

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