GROWTH AND COLLABORATION IN SUSTAINABLE FINANCE LITERATURE: BIBLIOMETRIC ANALYSIS

a Kasmawati, bInova Fitri Siregar, cZulher, dRani Munika, eRahmawati

ABSTRACT

Objective: Research in the field of sustainable finance aims to understand the development and trends of sustainable finance over time and the relationship of keywords related to sustainable finance and research developments with authors who are very influential in further research. This research helps identify projects or sectors that contribute positively to sustainability and identify environmental and social risks that may result from investment activities. Additionally, to encourage innovation and development of financial products that support sustainability goals.

Theoritical framework: Sustainable finance promotes sustainable business practices, including transparency, prevention of human rights violations, diversity, and positive societal contributions. The greenwashing phenomenon occurs a lot nowadays, where companies or products claim to have a positive or sustainable environmental impact, but the reality is inconsistent with these claims. Enhancing supervision, transparency, and strict sanctions are crucial to address these issues. Efforts are necessary to increase understanding and education about sustainable finance so that more parties can take relevant actions.

Methods: Bibliometric analysis, there are dozens of tools to collect and analyze data. In this research, the tool to measure sustainable finance trends is Scopus, one of the popular academic databases for bibliometric analysis. This tool ensures access to scholarly journals, conferences, and other academic literature. Scopus offers rich information on publications, citations, citation index, and other metrics for bibliometric analysis. VOS viewer is a visualization tool to visualize collaboration networks, keyword clustering, and citation patterns in bibliometric analysis.

Result & Conclusion: English is the most widely used language, with 644 total publications or 96.55% of Russian, French, German, Italian, Spanish and Ukrainian. In 2020, the publication trends related to sustainable finance were the most researched at 77 publications. It is identified that in 2022 the emergence of climate risks and opportunities associated with climate change will continue to be the research focus. There is a yellow cluster signifying the novelty associated with sustainable finance, i.e., Nigeria, New Zealand, Greece, and Finland. The second cluster is marked in light green. In 2021, sustainable finance research will be carried out in Italy, Germany, Spain, China, Bahrain, Malaysia and Indonesia. Furthermore, the third

a Magister Akuntansi, STIE Bangkinang University of lancang Kuning, E-mail: kasmawati0873@gmail.com,
Orcid: https://orcid.org/0009-0009-6661-7744
b Magister Akuntansi, University of lancang Kuning, E-mail: inova@unilak.ac.id,
Orcid: https://orcid.org/0000-0003-0886-2572
c Doktor, STIE Banking, Master of Management program, E-mail: zulher@pascabangkinang.ac.id,
Orcid: https://orcid.org/0009-0007-6659-7267
d Magister Akuntansi, STIE Bangking, Accounting study program, E-mail: raniminika@gmail.com,
Orcid: https://orcid.org/0009-0004-6632-5999
e Magister sains, STIE Bangking, Accounting study program, E-mail: rahmawati@stiebangkinang.ac.id,
Orcid: https://orcid.org/0009-0007-0568-0470

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cluster marked in solid green in 2020, the United Kingdom dominates research, and the last cluster in purple in 2019 includes Switzerland, Denmark, Brazil, Canada, the United States, and South Africa.

Implications: Implications of this study is Sustainable finance entails managing risks and uncertainties associated with environmental and social factors. Measuring and managing these risks involve assumptions and predictions that may have uncertainties.

Contribution / Originality: Originality in this research is understanding the development, trends of sustainable finance over time, and understanding the relationship of keywords related to sustainable finance, and the advancement of research with authors who are prominent in further study.

Keywords: sustainable finance, sustainability, finance, sustainability development, bibliometric analysis.

CRESCIMENTO E COLABORAÇÃO NA LITERATURA FINANCEIRA SUSTENTÁVEL: ANÁLISE BIBLIOMÉTRICA

RESUMO

Objetivo: A investigação no domínio do financiamento sustentável visa compreender o desenvolvimento e as tendências do financiamento sustentável ao longo do tempo e a relação de palavras-chave relacionadas com o financiamento sustentável e o desenvolvimento da investigação com autores que são muito influentes em novas investigações. Esta investigação ajuda a identificar projetos ou setores que contribuam positivamente para a sustentabilidade e a identificar os riscos ambientais e sociais que possam resultar de atividades de investimento. Além disso, incentivar a inovação e o desenvolvimento de produtos financeiros que apoiem os objetivos de sustentabilidade.

Quadro teórico: o financiamento sustentável promove práticas empresariais sustentáveis, incluindo a transparência, a prevenção de violações dos direitos humanos, a diversidade e contribuições sociais positivas. O fenômeno da lavagem verde ocorre muito hoje em dia, onde empresas ou produtos alegam ter um impacto ambiental positivo ou sustentável, mas a realidade é inconsistente com essas alegações. O reforço da supervisão, da transparência e das sanções rigorosas é crucial para resolver estas questões. São necessários esforços para aumentar a compreensão e a educação sobre o financiamento sustentável, de modo a que mais partes possam tomar medidas relevantes.

Métodos: Análise bibliométrica, existem dezenas de ferramentas para coletar e analisar dados. Nesta pesquisa, a ferramenta para medir as tendências de financiamento sustentável é a Scopus, uma das bases de dados acadêmicas mais populares para análise bibliométrica. Essa ferramenta garante acesso a revistas acadêmicas, conferências e outras literaturas acadêmicas. A Scopus oferece informações ricas sobre publicações, citações, índice de citações e outras métricas para análise bibliométrica. O visualizador VOS é uma ferramenta de visualização para visualizar redes de colaboração, clustering de palavras-chave e padrões de citação em análise bibliométrica.

Resultado & Conclusão: O inglês é a língua mais utilizada, com um total de 644 publicações ou 96,55% de russo, francês, alemão, italiano, espanhol e ucraniano. Em 2020, as tendências de publicação relacionadas ao financiamento sustentável foram as mais pesquisadas em 77 publicações. Identifica-se que, em 2022, o surgimento de riscos climáticos e de oportunidades associadas às alterações climáticas continuará a ser o foco da investigação. Há um aglomerado

amarelo que significa a novidade associada ao financiamento sustentável, ou seja, Nigéria, Nova Zelândia, Grécia e Finlândia. O segundo aglomerado está marcado em verde-claro. Em 2021, a pesquisa de financiamento sustentável será realizada na Itália, Alemanha, Espanha, China, Bahrein, Malásia e Indonésia. Além disso, o terceiro cluster marcado em verde sólido em 2020, o Reino Unido domina a pesquisa e o último cluster em roxo em 2019 inclui Suíça, Dinamarca, Brasil, Canadá, Estados Unidos e África do Sul.

Implicações: Implicações deste estudo é Finanças sustentáveis implica a gestão de riscos e incertezas associadas a fatores ambientais e sociais. A medição e a gestão destes riscos envolvem pressupostos e previsões que podem ter incertezas.

Contribuição / Originalidade: Originalidade nesta pesquisa é entender o desenvolvimento, tendências de finanças sustentáveis ao longo do tempo, e entender a relação de palavras-chave relacionadas a finanças sustentáveis, e o avanço da pesquisa com autores que são proeminentes em estudos posteriores.

Palavras-chave: finanças sustentáveis, sustentabilidade, finanças, desenvolvimento sustentável, análise bibliométrica.

1 INTRODUCTION

Currently, climate change and environmental degradation are serious issues for our planet. However, phenomena such as global warming (Paterson, 2013), increased air pollution, forest destruction, and species extinction threaten the balance of ecosystems (Browman & Stergiou, 2004). Sustainable finance is geared towards supporting investments that contribute to environmental protection and reduce negative impacts on nature (Sullivan, 2012). Companies increasingly recognize the importance of social responsibility and its impact on society and the environment. Sustainable finance promotes sustainable business practices, including transparency, prevention of human rights violations, diversity (Hassan et al., 2015), and positive societal contributions. The business sector has the potential to be a catalyst for sustainable development (Setiawan, 2023).

With transparency and the problem of ethical lapses, consumers are increasingly concerned about the environmental and social impacts of the products and services they buy. According to (Aggarwal & Elembilassery, 2018) the demand for environmentally friendly and ethical products is rising. Sustainable finance helps facilitate investment in sectors that meet these criteria, encouraging companies to innovate and produce more durable solutions.

Not only the participation of external and internal parties within the company to strive for the implementation of sustainable finance but governments and regulators are progressively recognizing the imperative to integrate sustainability considerations in the

financial system (Kuhn, 2022). They can foster sustainable finance practices through regulations, incentives and policies that promote environmentally and socially friendly investments. Binding regulations should be reinforced by the latest technologies that can and have enabled the development of new solutions to sustainability challenges. For instance, renewable energy and energy efficiency technologies support investment in a sustainable energy sector (Qin et al., 2022). Sustainable finance facilitates the flow of funds to these innovative sectors, encouraging the development of more sustainable technologies (Sharma et al., 2022)

The phenomenon gap in this study is the greenwashing phenomenon that is prevalent today, where companies or products claim to have a positive or sustainable environmental impact, but the reality is inconsistent with these claims (Schumacher, 2022). This may deceive investors and reduce the integrity of the sustainable finance market (López-Arceiz et al., 2020). Enhancing supervision, transparency, and strict sanctions are crucial to address these issues. Despite the development of sustainable finance regulations and frameworks (Dimmelmeier, 2021), implementation and compliance remain unclear. Inconsistent or unclear regulations can complicate adopting sustainable finance practices and cause uncertainty for market participants (Bilgin et al., 2021), the last is that awareness of sustainable finance and a broad comprehension of its benefits remain limited. Many investors and financial institutions are incomprehensible with how to integrate sustainable finance factors in investment decision-making. Efforts are necessary to increase understanding and education about sustainable finance so that more parties can take relevant actions.

Research in the field of sustainable finance aims to understand developments and trends over time and the relationship of keywords related to sustainable finance and research developments with prominent authors in further research. This research allows to identify projects or sectors that contribute positively to sustainability (Gunawan, 2021), identify environmental and social risks that may emerge from investment activities, and encourage innovation and development of financial products that support sustainability goals (Chen et al., 2023). With previous literature, opportunities and challenges in establishing financial instruments such as green bonds (Suljić Nikolaj et al., 2023), sustainable sukuk, or sustainable investment funds can be determined and are expected to become tools to encourage widespread adoption of sustainable finance practices (Esty, 2020). By generating robust evidence and knowledge, research can contribute to changing

perceptions and encouraging stakeholders to integrate sustainability considerations into financial decision-making. From the explanation above, the Research Questions in this study are:

1.   What is the trend of research on sustainable finance based on the number of publications in a certain period?

2.   What are the main dominant topics in sustainable finance research?

3.   How is the collaboration between authors and institutions in sustainable finance research?

4.   What is the role of the contribution of publications by certain countries in the development of research on sustainable finance?

5.   What is the relationship between sustainable finance research and related topics such as finance, investment, environment, and social?

2 LITERATURE REVIEW

As attested by (Ren et al., 2023), sustainable finance concepts, instruments, and strategies, as well as the role of financial institutions in promoting positive change. Innumerable literature discusses the concept and definition of sustainable finance, covering the notion of sustainable finance, related financial instruments, and ESG factors integrated into investment decision-making and financial policies (Finger & Rosenboim, 2022). The impact of sustainable investment on corporate financial performance, risk, and sustainability, entails the study of the relationship between ESG factors and financial performance, firm value, management risk, and environmental and social impacts.

The changes needed in the financial system to support sustainable development (Todaro & Smith, 2013), addresses issues such as climate change, biological diversity, water, energy, and sustainable society. According to (Suljić Nikolaj et al., 2023) sustainable finance instruments include green bonds, sustainable bonds, sustainable sukuk, and sustainable investment funds.

Furthermore, the development of sustainable finance is able to explore the characteristics, performance, reporting mechanisms, and challenges in developing and adopting instruments that address the role of financial institutions, including banks, insurance companies, and non-bank financial institutions, in promoting sustainable finance practices (Strauß, 2021). Also, the integration of ESG factors in investment

policies, sustainable project financing, and climate change risk assessment (Peixoto et al., 2022)

2.1 BIBLIOMETRIC ANALYSIS

Bibliometric analysis is a research method used to analyze, measure, and evaluate the quantity, quality, and impact of scientific publications documented in bibliographic databases (van Eck & Waltman, 2010). All topics, disciplines and research areas that can thoritically be published and generate knowledge should benefit from bibliometric analysis (Sai & Pinapati, 2023). This method involves collecting bibliographic data, such as article titles, author names, publishing journals, and other information, and using statistical methods to identify trends, patterns, and relationships among publications (Shiau et al., 2017). In addition, it measures the quantity of publications, such as the number of articles produced by a particular author, institution, or country. Quantity indices generally include publication counts, citation counts, and journal impact factors.

Analyzing relationships and connections between authors, journals, institutions, or keywords in scientific publications. It enables identifying research collaborations, disciplinary networks, or trends in collaboration between countries. With bibliometric analysis, data visualization involves using graphs, diagrams, or other visualizations to display the findings of the analysis visually. This contributes to understanding and presenting the data in a way that is easier to apprehend.
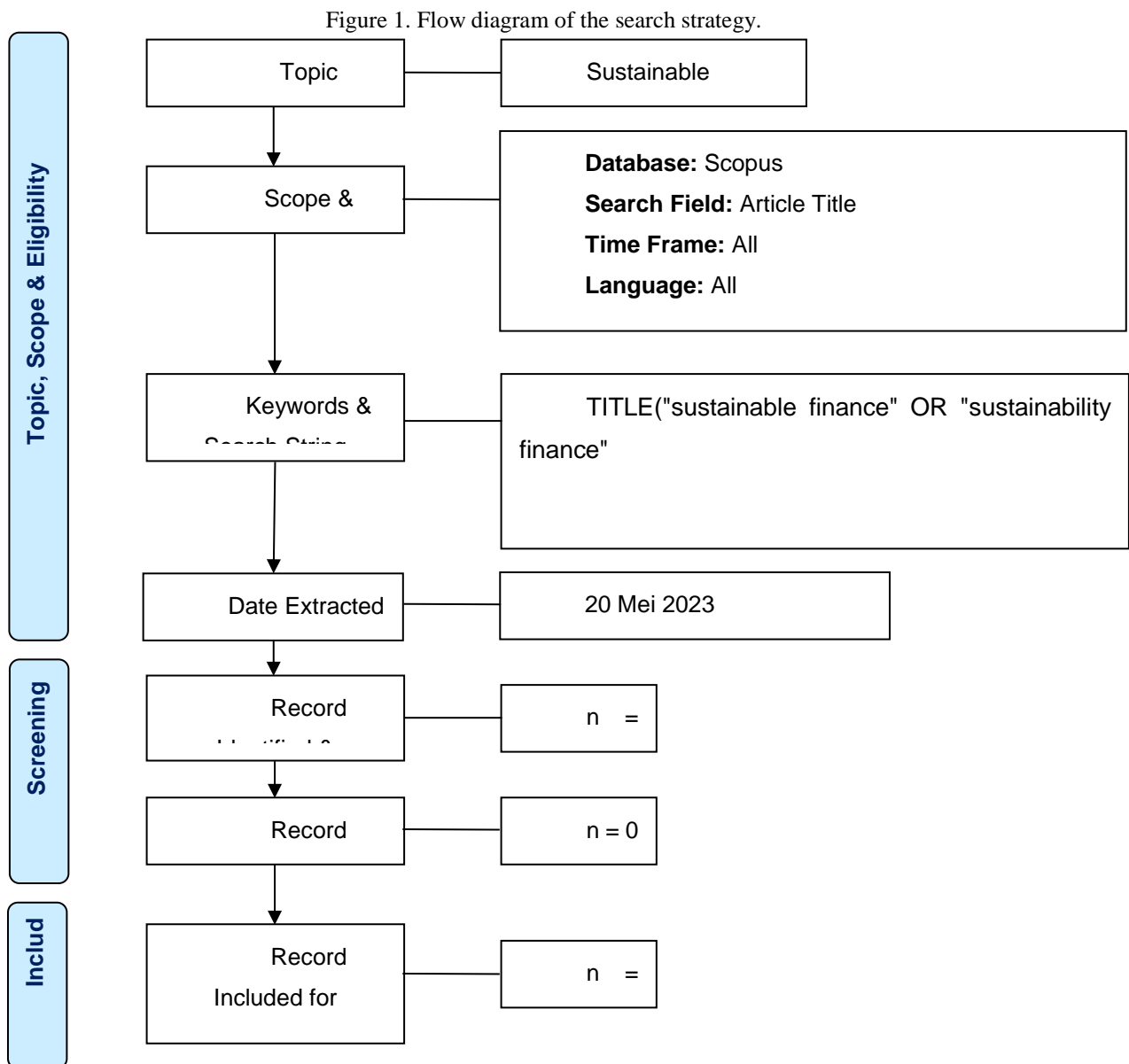
3 METHODS

This method implicates using citations as an indicator of the impact and importance of a publication. Some commonly used citation analysis methods include Citation Count, which counts the number of citations a publication receives. Citation Index Using indicators such as the Hirsch index (h-index) or citation index to measure a researcher's or publication's impact and importance (Boyack & Klavans, 2010). Citation Network Analysis: Analyzes the citation network between publications to identify the most influential works and the relationship between these publications.

Another method used is the analysis of citation patterns that arise when other publications cite together two or more publications. This is useful for identifying clusters of interrelated research or emerging research trends (Boyack & Klavans, 2010), involving

algorithms to cluster publications based on citation patterns or keywords that frequently co-occur. This makes it easy to identify related topics or research areas and form clusters.

3.1 SEARCH STRATEGY

Figure 1. Flow diagram of the search strategy.

Source: Zakaria et al. (2020), Moher et al. (2009)

3.2 DATA ANALYSIS

Bibliometric data analysis involves collecting bibliographic data from scientific publications and using statistical methods to identify patterns, trends and relationships among publications on sustainable finance (Naeem et al., 2022), a unified database for bibliometric analysis. Some popular data sources in this field include Scopus, which

includes publications relevant to sustainable finance (Naeem et al., 2022). In this study, keywords relevant to sustainable finance were used. This includes terms such as "sustainable finance" and "sustainability finance."

3.3 TOOLS

Eclectic tools can be used to collect and analyze data in Bibliometric analysis. In this study, the tool used to measure sustainable finance trends is Scopus, one of the popular academic databases for bibliometric analysis (Aytaç & Khayet, 2023). This tool provides access to scientific journals, conferences, and other academic literature. Scopus provides rich information on publications, citations, citation index, and other metrics that can be used in the bibliometric analysis (Aytaç & Khayet, 2023)

VOS viewer is a visualization tool for visualizing collaboration networks, keyword clustering, and citation patterns in bibliometric analysis (van Eck & Waltman, 2010). The tool allows users to create interactive visual maps that facilitate understanding of the relationships between publications, authors, keywords, and other entities.

4 RESULTS

4.1 DOCUMENTS PROFILES

Source Type refers to the type or category of publication sources used in the analysis, where different types of publication sources can be classified by format. Bibliometric analysis can administer track publication trends over time with a source type (Garfield, 1979). The analysis, for instance, can demonstrate if there has been a rise in publications in scholarly journals or a rise in publications in other formats. Table 2 indicates that the type of journal is the most published, with a total publication of 517 journals with a percentage level of 77.74%, followed by books (80), Conference Proceedings (41), Book Series (25), and Trade Journal (2).

Table 2. Source Type

Source Type	Total Publications (TP)	Percentage (%)
Journal	517	77.74%
Book	80	12.03%
Conference Proceeding	41	6.17%
Book Series	25	3.76%
Trade Journal	2	0.30%

Source: Prepared by the authors (2023)

Furthermore, the following profile document is viewed from the language used in the publication. The goal is to analyze the language of profile documents, and clusters or groups of publications that use the same language can be identified. As a result, using the language of the paper can help map the research area (Boyack & Klavans, 2010). In Table 3, English is the most widely used language, namely 644 total publications or 96.55% of Russian, French, German, Italian, Spanish and Ukrainian.

Table 3. Languages

Language	Total Publications (TP)	Percentage (%)
English	644	96.55%
Russian	8	1.20%
French	6	0.90%
German	4	0.60%
Italian	3	0.45%
Spanish	1	0.15%
Ukrainian	1	0.15%

*one document has been prepared in dual languages
Source: Prepared by the authors (2023)

Moreover, the last in the profile document is the subject area. The purpose of identifying the subject area is to assist in identifying the research field or subject that is most widely explored by publications in bibliometric analysis (Mangione, 2001). It also allows for the mapping of research subjects and the understanding of the relationships between different topics.

Table 4 subject area shows that the total publications in the social sciences area are the most numerous at 285 publications or 42.86%, then Economics, Econometrics and Finance (283), Business, Management and Accounting (278), Environmental Science (233), Energy (126), Engineering (88), Computer Science (54), Earth and Planetary Sciences (34), Agricultural and Biological Sciences (22).

Table 4. Subject Area

Subject Area	Total Publications (TP)	Percentage (%)
Agricultural and Biological Sciences	22	3.31%
Arts and Humanities	17	2.56%
Biochemistry, Genetics and Molecular Biology	1	0.15%
Business, Management and Accounting	278	41.80%
Chemical Engineering	6	0.90%
Chemistry	3	0.45%
Computer Science	54	8.12%
Decision Sciences	21	3.16%
Earth and Planetary Sciences	34	5.11%
Economics, Econometrics and Finance	283	42.56%
Energy	126	18.95%
Engineering	88	13.23%
Environmental Science	233	35.04%

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Materials Science	3	0.45%
Mathematics	13	1.95%
Medicine	12	1.80%
Multidisciplinary	1	0.15%
Nursing	1	0.15%
Physics and Astronomy	3	0.45%
Psychology	7	1.05%
Social Sciences	285	42.86%

Source: Prepared by the authors (2023)

4.2 PUBLICATION TRENDS

Identifying the most significant papers on the topic of sustainable finance can be
aided by using Publication Trends (Boyack & Klavans, 2010). This entails evaluating
publications' citation and impact rates as well as their contribution to the advancement of
knowledge.

Figure 2. Total Publications and Citation by Year
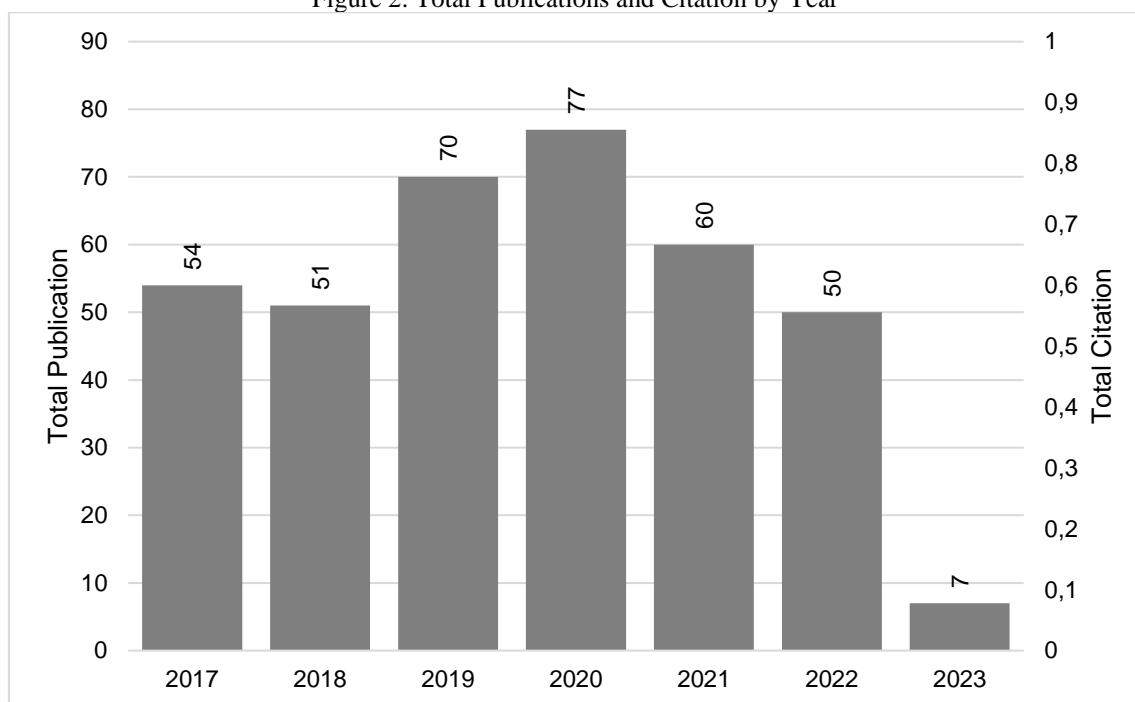
Source: Prepared by the authors (2023)

Table 2 shows that in 2017 the total number of publications on sustainable finance
was 54 publications; in 2018, there were 51 publications; in 2019, publications on
sustainable finance rose to 70 publications; in 2020, the trend of publications related to
sustainable finance was the most researched at 77 publications. This was identified that
in 2022 the emergence of climate risks and opportunities associated with climate change
would continue to be the research focus. Then by understanding the financial risks faced
by financial institutions and market participants due to climate change, as well as

identifying investment opportunities in sustainable and low-carbon sectors, in 2021 and 2022, the trend of publications on sustainable finance fell to 60 and 50 publications.

4.3 PUBLICATIONS BY INSTITUTIONS

In bibliometric analysis, "Publications by Institutions" is employed to look at the relative roles and contributions of different institutions in a field of research. According to (Boyack & Klavans, 2010), it plays a role in mapping collaboration networks between institutions, identifying centers of research excellence, measuring the scientific productivity of an institution, and comparing institutional performance in terms of publications and scientific impact.

Table 5 shows that the University of Oxford has 16 total publications, University College London with 13 publications, SOAS University of London (9), Universitetet i Oslo (8), Università Bocconi (8), Alma Mater Studiorum Università di Bologna (8), Stockholm Environment Institute (7), Copenhagen Business School (7), Griffith University (7), Kungl. The United Kingdom most widely carries out the study on sustainable finance, and this is due to a solid commitment to sustainable development and reducing negative impacts on the environment. The UK government has adopted policies and initiatives encouraging sustainable finance, including regulations and incentives that lead to green investment and disclosure of sustainable information.

Table 5. Most productive institutions with minimum of five publications

Institution	Total Publications (TP	Percentage (%)	Country
University of Oxford	16	2.41%	Inggris
University College London	13	1.95%	Inggris
SOAS University of London	9	1.35%	Inggris
Universitetet i Oslo	8	1.20%	Norwegia
Università Bocconi	8	1.20%	Italia
Alma Mater Studiorum Università di Bologna	8	1.20%	Italia
Stockholm Environment Institute	7	1.05%	Italia
Copenhagen Business School	7	1.05%	Denmark
Griffith University	7	1.05%	Australia
Kungl. Vetenskapsakademien	6	0.90%	Swedia

Source: Prepared by the authors (2023)

4.4 PUBLICATIONS BY COUNTRIES

"Publications by Countries" is used to look at the role and contribution of countries in the research field under study (Boyack & Klavans, 2010). This can be useful for

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charting worldwide research trends, identifying countries that are pioneers in particular areas of research, and assessing how well different nations do in terms of research.

The six European regions that support sustainable finance are the United Kingdom (91), Italy (77), Germany (60), France (34), Spain (32), and Switzerland (31). This is because Europe has adopted various regulations and policy frameworks that support sustainable finance. Examples are the Sustainable Finance Disclosure Regulation (SFDR) and the Taxonomy Regulation, which set disclosure standards and classify sustainable activities in the financial sector. Furthermore, Europe has also launched various initiatives and programs to facilitate the development of sustainable finance. Examples are the European Sustainable Finance Initiative, Allianz Climate Solutions, and various programs supporting sustainable public and private finance.

Table 6. Top 10 Countries contributed to the publications

Country	Total Publications (TP)	Percentage (%)	Continent
United Kingdom	91	13.68%	Europe
Italy	77	11.58%	Europe
United States	66	9.92%	North America
Germany	60	9.02%	Europe
China	42	6.32%	Asia
Australia	36	5.41%	Oceania
France	34	5.11%	Europe
India	34	5.11%	Asia
Spain	32	4.81%	Europe
Switzerland	31	4.66%	Europe

Source: Prepared by the authors (2023)

Figure 3. Country

Source: Prepared by the authors (2023)

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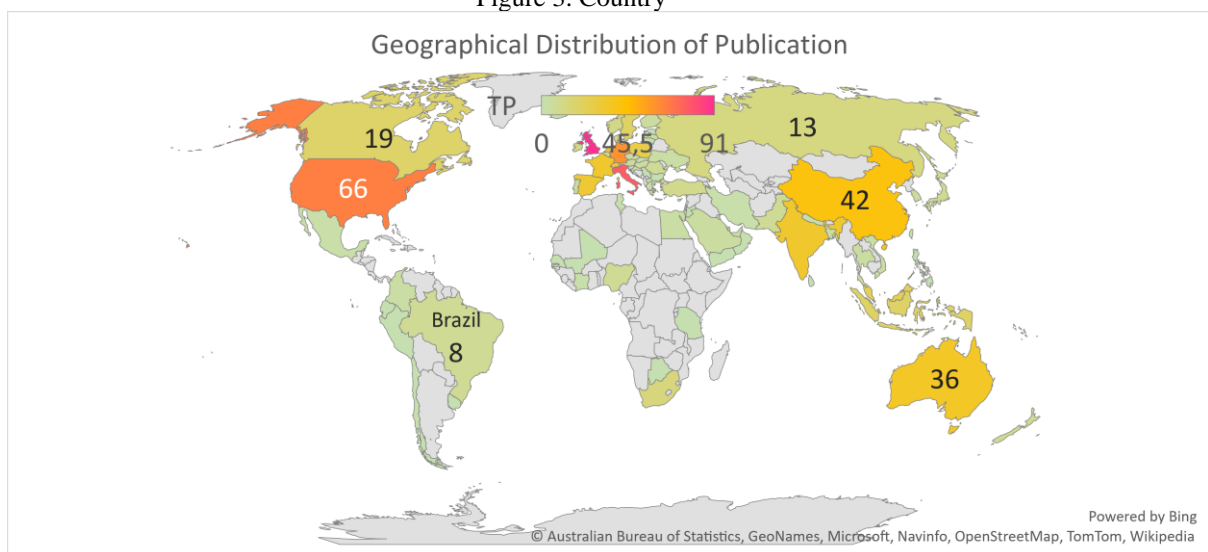
4.5 PUBLICATIONS BY SOURCE TITLES

The role of "Publications by Source Titles" in the bibliometric analysis is to identify and analyze the contribution of scientific publications from various sources or journals in a particular field of research (Boyack & Klavans, 2010). This data aids in grasping the function, position, and relative contribution of different journals or publication sources in the study area under consideration.

Table 7 reveals that the International Journal of Productivity and Performance Management with a total publication of 115 with a total publication of 3218, but in the International Journal of Operations and Production Management, although the total publication is solely 75 publications however, the total citations accumulate are 10248, followed by Measuring Business Excellence (62), International Journal of Business Performance Management (47), Production Planning and Control (39), International Journal of Production Research (39), Management Accounting Research (35), Public Money and Management (35), International Journal of Production Economics (35), Total Quality Management and Business Excellence (24), Benchmarking (23), Management Decision (21), Studies in Managerial and Financial Accounting (21), Accounting, Organizations and Society (20), Public Performance and Management Review (19).

Table 7. Most active source titles

Row Labels	TP	NCP	TC	C/P	C/CP	h-index	g-index	m-index
International Journal of Productivity and Performance Management	115	107	3518	30.59	32.88	35	55	0.0290
International Journal of Operations and Production Management	75	73	10248	136.64	140.38	43	75	0.0345
Measuring Business Excellence	62	57	1634	26.35	28.67	24	39	0.0281
International Journal of Business Performance Management	47	44	828	17.62	18.82	14	27	0.0171
Production Planning and Control	39	35	1473	37.77	42.09	23	38	0.0465
International Journal of Production Research	39	38	2366	60.67	62.26	25	39	0.0491
Management Accounting Research	35	34	3566	101.89	104.88	27	35	0.0462
Public Money and Management	35	35	835	23.86	23.86	15	28	0.0209
International Journal of Production Economics	35	35	4544	129.83	129.83	27	35	0.0450
Total Quality Management and Business Excellence	24	22	411	17.13	18.68	14	20	0.0428
Benchmarking	23	22	1828	79.48	83.09	14	23	0.0515
Management Decision	21	21	912	43.43	43.43	14	21	0.0420
Studies in Managerial and Financial Accounting	21	15	56	2.67	3.73	4	6	0.0159
Accounting, Organizations and Society	20	19	3332	166.60	175.37	17	20	0.0644
Public Performance and Management Review	19	19	298	15.68	15.68	11	17	0.0588

Source: Prepared by the authors (2023)

4.6 CITATION METRICS

Citation Metrics in bibliometric analysis measure and analyze the influence or impact of a scientific publication through the number of citations it receives. Citation Metrics data identify the most influential publications in a field of research, evaluate the quality and impact of research, and track trends and developments in research (Boyack & Klavans, 2010). Table 8 uses sustainable finance data from as many as 665 papers within 31 years with 5431 citations and 175.19 citations per year.

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Table 8. Citations metrics

Metric	Data
Papers	665
Citations	5431
Years	31
Cites_Year	175.19
Cites_Paper	8.17
Cites_Author	2805.72
Papers_Author	372.05
Authors_Paper	2.45
h_index	36
g_index	55

Source: Prepared by the authors (2023)

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Highly Cited Documents

Highly Cited Documents in bibliometric analysis specify and analyze publications that significantly contribute to the research field, and Publications that receive a high number of citations indicate the influence and relevance of the research. It then reflects research that significantly impacts the scientific community (Boyack & Klavans, 2010). It evaluates the impact of research, researchers' reputation, and publications' quality. Highly Cited Documents are often used as an essential indicator in assessing research and researchers.

Table 9 shows the authors who have the highest influence in citations, starting from M. Koblinsky, C.A. Moyer, C. Calvert, J. Campbell, O.M.R. Campbell, A.B. Feigl, W.J. Graham, L. Hatt, S. Hodgins, Z. Matthews, L. McDougall, A.C. Moran, A.K. Nandakumar, A. Langer (2016) under the title Quality maternity care for every woman, everywhere: a call to action with a total citation of 239, C. Flammer (2021) under the title Corporate green bonds with a total citation of 224, S. Drempetic, C. Klein, B. Zwergel (2020) under the title The Influence of Firm Size on the ESG Score: Corporate Sustainability Ratings Under Review (172), A.W.H. Yip, N.M.P. Bocken (2018) under

the title Sustainable business model archetypes for the banking industry (153), A. Sikora (2021) under the title European Green Deal - legal and financial challenges of the climate change (86), L. Pham, T. Luu Duc Huynh (2020) under the title How does investor attention influence the green bond market (76), A.M. Fatemi, I.J. Fooladi (2013) under the title Sustainable finance: A new paradigm (73), V. Galaz, B. Crona, A. Dauriach, B. Scholtens, W. Steffen (2018) under the title Finance and the Earth system - Exploring the links between financial actors and non-linear changes in the climate system (72), A. Pueyo (2018) under the title What constrains renewable energy investment in Sub-Saharan Africa? A comparison of Kenya and Ghana (71), M.K. Hassan, M.R. Rabbani, M.A. Mohd. Ali (2020) with the title Challenges for Islamic Finance and Banking in the post-COVID Era and the Role of Fintech (67).

Table 9. Top 10 highly cited articles

No.	Author(s)	Title	TC	Cite per Year
1	M. Koblinsky, C.A. Moyer, C. Calvert, J. Campbell, O.M.R. Campbell, A.B. Feigl, W.J. Graham, L. Hatt, S. Hodgins, Z. Matthews, L. McDougall, A.C. Moran, A.K. Nandakumar, A. Langer (2016)	Quality maternity care for every woman, everywhere: a call to action	239	34.14
2	C. Flammer (2021)	Corporate green bonds	224	112
3	S. Drempetic, C. Klein, B. Zwergel (2020)	The Influence of Firm Size on the ESG Score: Corporate Sustainability Ratings Under Review	172	57.33
4	A.W.H. Yip, N.M.P. Bocken (2018)	Sustainable business model archetypes for the banking industry	153	30.6
5	A. Sikora (2021)	European Green Deal â€" legal and financial challenges of the climate change	86	43
6	L. Pham, T. Luu Duc Huynh (2020)	How does investor attention influence the green bond market?	76	25.33
7	A.M. Fatemi, I.J. Fooladi (2013)	Sustainable finance: A new paradigm	73	7.3
8	V. Galaz, B. Crona, A. Dauriach, B. Scholtens, W. Steffen (2018)	Finance and the Earth system â€" Exploring the links between financial actors and non-linear changes in the climate system	72	14.4
9	A. Pueyo (2018)	What constrains renewable energy investment in Sub-Saharan Africa? A comparison of Kenya and Ghana	71	14.2
10	M.K. Hassan, M.R. Rabbani, M.A. Mohd. Ali (2020)	Challenges for the islamic finance and banking in post COVID era and the role of Fintech	67	22.33

Source: Prepared by the authors (2023)

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4.7 TOP KEYWORDS

The Top Keywords in the bibliometric analysis are to identify the most frequently used keywords in scientific publications in a particular field of research. Top Keywords serves insight into the most discussed and essential topics in the literature, and through Top Keywords analysis, can highlight if there are topics that remain rarely discussed or have limited research (Boyack & Klavans, 2010). This leads researchers to fill research gaps and track research progress.

Table 10 exhibits that sustainable finance is still the primary keyword in publications, namely 351 or 52.78% of the total publications, then Sustainable Development, Sustainability, Finance, ESG, Climate Change, Investment, Investments, Green Finance, Financial System, Green Bonds, European Union, Economics, Sustainable Development Goals, Corporate Social Responsibility, Environmental Economics, Risk Assessment, Climate Finance. From the existing keywords, it can be inferred that there are links and relationships with sustainable finance.

Table 10. Top author's keywords

Keywords	Total Publications (TP)	Percentage (%)
Sustainable Finance	351	52.78%
Sustainable Development	122	18.35%
Sustainability	119	17.89%
Finance	79	11.88%
ESG	64	9.62%
Climate Change	60	9.02%
Investment	40	6.02%
Investments	39	5.86%
Green Finance	37	5.56%
Financial System	31	4.66%
Green Bonds	31	4.66%
European Union	29	4.36%
Economics	26	3.91%
Sustainable Development Goals	26	3.91%
Corporate Social Responsibility	22	3.31%
Environmental Economics	21	3.16%
Banking	19	2.86%
Risk Assessment	19	2.86%
Climate Finance	18	2.71%

Source: Prepared by the authors (2023)

## 4.8 CO-AUTHORSHIP ANALYSIS

4.8.1 Co-authorship by countries

Co-authorship by countries in bibliometric analysis is to identify and analyze research collaboration between countries in a particular field or topic. Co-authorship by

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countries' data captures information about collaboration between authors from distinct countries in a single publication (Boyack & Klavans, 2010)

Figure 4 indicates several color points, which are divided into several clusters; the yellow cluster in yellow indicates renewal related to sustainable finance, Nigeria, Newzeland, Greece, and Finland, then the second cluster is marked in light green; research in 2021, sustainable finance research will be carried out in Italy, Germany, Spain, China, Bahrain, Malaysia and Indonesia. Furthermore, the United Kingdom dominates the third cluster in solid green in 2020 research on sustainable finance. The last cluster with purple color in 2019 is Switzerland, Denmark, Brazil, Canada, the United States, and South Africa.

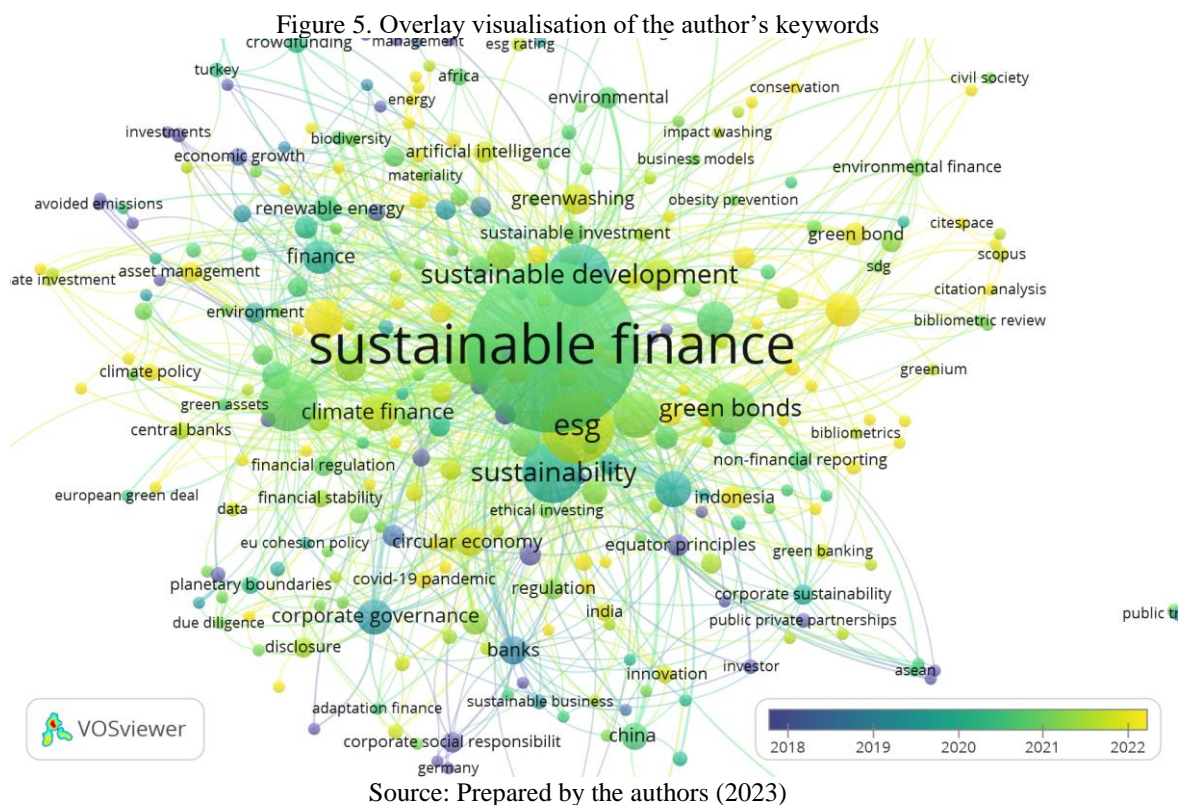Figure 4. Network visualisation map of the co-authorship by countries
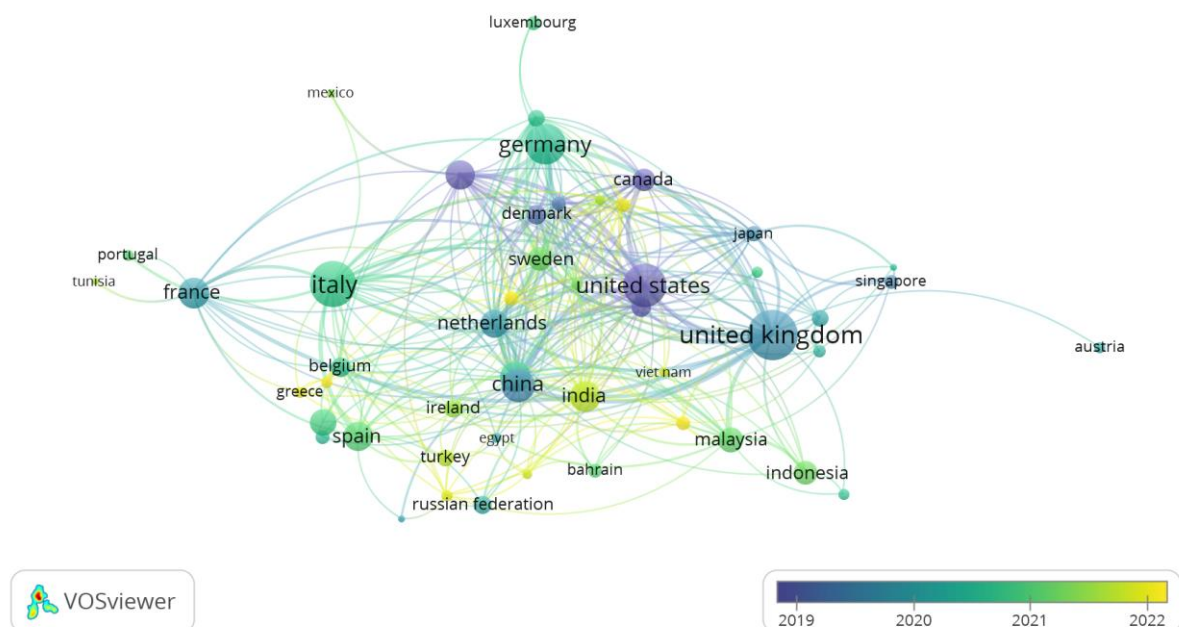
Source: Prepared by the authors (2023)

4.9 CO-OCCURRENCE ANALYSIS

4.9.1 Co-occurrence analysis of author's keywords

Co-occurrence analysis on keywords used by authors in publications aims to assist in exploring the relationship between interrelated topics in research and form thematic clusters consisting of keywords that often appear together (Boyack & Klavans, 2010).

In Table 5, the development of research on sustainable finance has appeared marked by purple clusters in 2018, starting from economic growth, economic sustainability, project finance, economic development, avoided emissions, and low carbon, while in 2019, it is marked by dark green clusters starting from sector banks, corporate governance, sustainability, corporate social responsibility, corporate sustainability, and social finance. In 2020, the most researched sustainable finance issues were characterized by light green clusters with enormous spheres related to climate change, climate risk, crowdfunding, green bonds, renewable energy, impact investing, and financial regulation. Yellow clusters characterize 2021 and 2022. In this cluster, the development of sustainable finance is more dominant to the novelty of the phenomena that occur; for example, sustainable finance is associated with covid 19 where the many keywords used are ESG, asset management, greenwashing, climate finance, climate policy, green bond, corporate social performance, SDGs, carbon neutrality, environmental sustainability, circular economy, innovation, and green digital finance, environmental regulation. The development of keywords through time reveals that economic sustainability is the most significant factor in being accountable for the products produced, allowing for both internal and external repercussions to be taken into account.

Figure 5. Overlay visualisation of the author's keywords

Source: Prepared by the authors (2023)

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4.10 CITATION ANALYSIS

4.10.1 Citation analysis by documents

Figure 6. Overlay visualisation map of the citation by documents
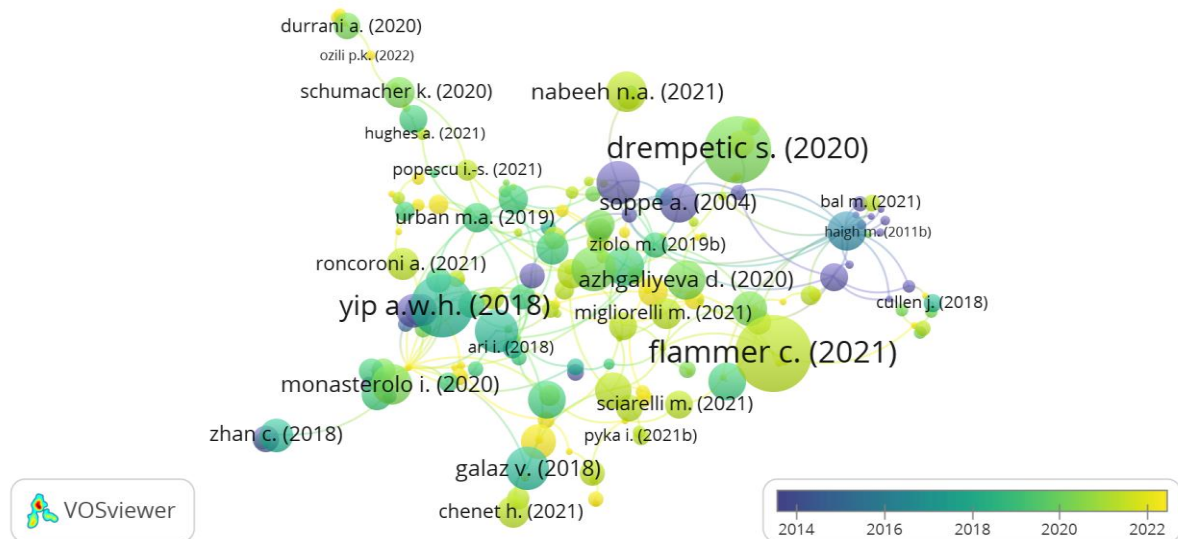
Source: Prepared by the authors (2023)

By conducting document-based citation analysis, researchers can measure the influence and relevance of a publication in the academic literature. The number and frequency of citations received by a document can give an indication of the extent to which the research is recognized and considered necessary. In Figure 6, many authors influence the development of research related to sustainable finance; Fatemi a.m (2013) conducted a study on "Sustainable Finance: A New Paradigm". Then developed in 2017 by (Ziolo, Filipiak, et al., 2019) with the title "Sustainable Finance Role in Creating Conditions for Sustainability Economics Growth and Development", with the existence of this research was developed again by (Ziolo, Pawlaczyk, et al., 2019) in 2019 with the title "Finance, Sustainability, and Negative Externalities: An Overview of the European Context". Furthermore, it was developed by Rizelo A in 2020 with the title "Sustainable Financial Partnership for the SDGs: The Case of Social Impact Bonds". Then developed by Shobande O. A. in 2021 regarding "A Multivariate Var Evaluating Sustainable Finance in Nigeria", followed by the next researcher developed again in 2022 by Labelle 2022 regarding "The Effect of Assurance Documentation Disclosure and Readability on Liquidity: Evidence from Green Bonds.".

5 DISCUSSION

This part of the discussion will answer several research questions. The first is the trend of research on sustainable finance based on the number of publications in a certain period. The study results show that in 2017 the total publications on sustainable finance amounted to 54 publications; in 2018, there were 51 publications; in 2019, publications on sustainable finance rose to 70 publications; in 2020, the trend of publications related to sustainable finance was the most researched at 77 publications. The results of this data processing will answer the second research question, namely, the dominant topics in sustainable finance research.

Thus, it is identified that in 2022 the emergence of climate risks and opportunities associated with climate change will continue to be the research focus, in addition, by understanding the financial risks faced by financial institutions and market participants due to climate change and identifying investment opportunities in sustainable and low-carbon sectors (Berretta & Harvey, 2022), however, in 2021 and 2022, the trend of publications on sustainable finance lessened.

The third research question is how the collaboration between authors and institutions in research on sustainable finance shows that the University of Oxford has 16 publications. Most studies on sustainable finance are conducted in the UK, and the results are supported by research (Qin et al., 2022), due to a strong commitment to sustainable development and reducing negative environmental impacts. The UK government has adopted policies and initiatives encouraging sustainable finance, including regulations and incentives that lead to green investment and disclosure of sustainable information.

Furthermore, answering the fourth research question related to the role of publication contributions by certain countries in the development of sustainable finance research, six European regions support sustainable finance, namely the United Kingdom (91), Italy (77), Germany (60), France (34), Spain (32), Switzerland (31). This is because Europe has adopted various regulations and policy frameworks that support sustainable finance. Examples are the Sustainable Finance Disclosure Regulation (SFDR) and the Taxonomy Regulation (Nedopil Wang et al., 2022), which set disclosure standards and classification of sustainable activities in the financial sector (Lucarelli et al., 2020). Europe has also launched various initiatives and programs to facilitate the development of sustainable finance. Examples are the European Sustainable Finance Initiative, Allianz

Climate Solutions, and various programs supporting sustainable public and private finance.

The last research question is How is the relationship between sustainable finance research and related topics such as finance, investment, environment, and social is the development of research on sustainable finance emerged marked by purple clusters in 2018 starting from economic growth, economic sustainability, project finance, economic development, avoided emission, low carbon, while in 2019 marked by dark green clusters starting from sector banks, corporate governance, sustainability, corporate social responsibility, corporate sustainability, and social finance. Then in 2020, the most researched sustainable finance issues are characterized by a light green cluster with clusters with the most prominent circles and are related to climate change, climate risk, crowdfunding, green bonds, renewable energy, impact investing, financial regulation and very then in 2021 and 2022 are characterized by yellow clusters. In this cluster, the development of sustainable finance is more dominant in the novelty of the phenomena that occur; for example, sustainable finance is related to COVID-19 where the keywords are ESG, asset management, greenwashing, climate finance, climate policy, green bonds, corporate social performance, SDGs, carbon neutrality, environmental sustainability, circular economy, innovation, green digital finance, environmental regulation.

Sustainable finance focuses more on sustainable financial practices, considering environmental and social risks in investment decision-making and risk management. Hence, the expected contribution of this research is for financial actors to identify and manage climate risk, biodiversity risk, and social risk in their financial activities. On the other hand, they also identify investment opportunities related to sustainability and the positive impact of sustainable finance will drive changes in more sustainable financial practices.

This comprises improvements in integrating environmental, social, and governance (ESG) factors in investment decision-making, risk management, and business strategy, and sustainable finance is expected to contribute to the development of financial instruments that promote sustainable investment. This covers developing and implementing instruments such as green bonds, social bonds, and sustainability bonds.

6 CONCLUSION

Sustainable finance is a rapidly growing field that integrates environmental, social and corporate governance (ESG) considerations into investment and financing decision-making. The history of its development includes several critical stages, from the beginning of the environmental movement to the rise of sustainable investment and the global agreement on climate change. Furthermore, the development of sustainable finance has been influenced by factors such as awareness of the environmental and social impacts of economic activities, the investment ethics movement, the principles of the UN Global Compact, corporate sustainability reports, the Equator Principles, and increased sustainable investment. However, the development of sustainable finance is also faced with challenges such as standardization, impact measurement, and the complexity of sustainable finance products. Nonetheless, there are opportunities for growth and innovation.

A limitation of this study lies in managing the risks and uncertainties associated with environmental and social factors. Measuring and managing these risks can involve assumptions and predictions that may have uncertainties. While much of the research in this area focuses on quantitative analysis, a deeper understanding of sustainable finance practices also requires a qualitative approach. Qualitative aspects such as views and perceptions of market participants, policy implementation, and case studies may provide valuable insights, yet it is challenging to quantify.

Research in this area can be affected by biases in data collection and analysis and generalizations made based on limited samples. Therefore, it is vital to recognize these limitations in interpreting research results and developing policy recommendations.

Future research could focus on developing better methods and frameworks for measuring the impact of sustainable finance. This includes developing indicators and metrics that can be used to measure the social, environmental and economic impacts of finance, investment and financing activities. It then focuses on financing sustainable innovations and technologies to accelerate the transition to a low-carbon and sustainable economy. This includes research on financing mechanisms that facilitate the developing and adoption of sustainable technologies.

However, in the context of climate change risk, further research could address the role of finance in reducing climate change risk and supporting adaptation and mitigation. This involves research on sustainable financial instruments that may reduce exposure to

climate risks and the development of policies and frameworks that facilitate the financing
of climate change projects.

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