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Exploring the Knowledge Structure and Development of ESG in Real Estate: A Bibliometric Approach

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Abstract

ESG, which denotes Environmental, Social, and Governance, constitutes a vital factor that affects the business operations and outcomes of various sectors and industries across the globe. The real estate industry is experiencing a rapid transformation that necessitates the incorporation of ESG into its fundamental practices and values. On the one hand, ESG enables real estate players to align their strategies and operations with global market developments and norms. On the other hand, ESG responds to the expectations and preferences of all the stakeholders, who are increasingly concerned about long-term sustainability. However, the existing literature has not yet established ESG in real estate as a holistic and stand-alone industry and research framework. Many studies have examined the environmental (E) factors, but the definitions of the social (S) and governance (G) factors remain unclear and are often mixed with corporate social responsibility (CSR). This study proposes ESG as a novel and holistic research framework for the real estate industry and conducts a bibliometric analysis of 28 bibliographic metadata retrieved from Scopus and the Web of Science following the PRISMA workflow. Clarifying the knowledge structure of ESG in real estate-related literature, this analysis presents the development trends and opportunities for future research from five perspectives: 1) overall development trend of scientific publications; 2) country performance; 3) world collaborative networks; 4) theoretical fundamentals (cited references and citations); and 5) thematic analysis.

Keywords: Environmental Social Governance, Corporate Social Responsibilities, Real Estate, Sustainability, Long-term Investment

1.0 INTRODUCTION

ESG refers to environmental, social, and governance factors or criteria that are used to measure the sustainability and ethical impact of an investment in a business or company (Clementino and Perkins, 2021), and helps stakeholders, including governments, businesses, investors, communities, and consumers, comprehend how a company approaches ESG-related opportunities and risks (Aroul et al., 2022). In recent years, ESG has gained increasing worldwide attention due to the growing awareness of environmental and social challenges (Tarmuji et al., 2016), regulatory requirements, and market demands (Newell, 2023). In addition, the ongoing climate-related disruption and the most recent COVID-19 pandemic have led to an accelerated global interest in ESG relevance (Aroul et al., 2022), both in academia and industry (Robinson and McIntosh, 2022).

ESG has also evolved into a significant component of the syntax applied in international real estate markets today (Newell & Marzuki, 2022). These days, ESG is taken into account during all phases of the lifecycles of a property, including due diligence (Salerno, 2021), acquisitions (Larsen, 2010), leasing (Hebb et al., 2010; Larsen, 2010), architectural design (Kempeneer et al., 2021), building construction (Hebb et al., 2010), and asset management (Brounen et al., 2021; Newell, 2023; Newell et al., 2023). Improvements in ESG performance have made ESG a necessity for investment in the real estate industry (Robinson & McIntosh, 2022); meanwhile, some challenges of implementing ESG in real estate are apparent, such as a lack of standardization (Eccles et al., 2017; Feng and Wu, 2021; Kempeneer et al., 2021; Newell, 2023), insufficient data (Eccles et al., 2017; Feng and Wu, 2021; Newell and Marzuki, 2022), and concerns of transparency (An et al., 2011; Brounen et al., 2021; Wang, 2023a; Yu et al., 2018).

The research undertaken within the framework of ESG on real estate-relevant studies has been mainly embodied through the environmental aspects (Newell and Marzuki, 2022; Robinson and McIntosh, 2022), and the social and governance factors are seen as integrated elements or a form of corporate social responsibility (CSR) (Chiang et al., 2019). The imbalanced study among the three factors of ESG and dependent research with other disciplines reveal that ESG, especially in real estate-related literature, is still a developing and non-holistic framework. Therefore, the motivation of this study is to promote ESG as a holistic research framework for real estate relevance, clear the current knowledge structure, and enlighten the research trends and evolving directions for future research. This study

adopts a mixed quantitative and qualitative bibliometric method (Aria and Cuccurullo, 2017), highlighting the following research questions to be explored:

RQ1: What is the overall trend of publication in the real estate-related literature on ESG studies?
RQ2: Which countries worldwide are leading the research field in ESG and real estate?
RQ3: What is the current collaborative network of authors in ESG and real estate?
RQ4: Which scientific publications have contributed the most citation and which references have been the most influential in the research field?
RQ5: What are the established thematic topics associated with the research field?

2.0 MATERIALS AND METHOD

This section outlines the methodologies employed to investigate the knowledge structure and development of ESG in real estate. In this study, the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) workflow for retrieving and identifying the bibliographic metadata was employed, as suggested by Page et al. (2021).

As shown in Figure 1, the whole workflow diagram was divided into four steps, and the first step was to identify the scientific documents. Elsevier's Scopus and Clarivate's Web of Science, as the most recognized bibliographic databases (Aria and Cuccurullo, 2017), were selected for data extraction. To ensure synchronization and reliability of the retrieved bibliographic data, the search in both databases was conducted simultaneously, and the same search logic was implemented: 1) "ESG" and "real estate" were used as two key query terms connected by the Boolean operator "AND", and topic searches were performed in both bibliographic databases; 2) the type of documents retrieved was limited to articles, book chapters, and review articles, and conference articles or conference papers were excluded (Adams et al., 2017); and 3) the language of the retrieved documents was limited to English. 36 records from Scopus and 44 records from the Web of Science were initially identified. Then, in the second step, the initially identified documents were screened using the bibliographic management program Zotero (McKeown and Mir, 2021), and 25 duplicates were detected. The 55 records after duplicates were continuously screened by their corresponding titles and abstracts; through the process, 27 records were seen as irrelevant or not properly relevant to the purpose of the research field. 28 documents were then assessed through a full-text study and were eligible to be included for further systematic meta-analysis.

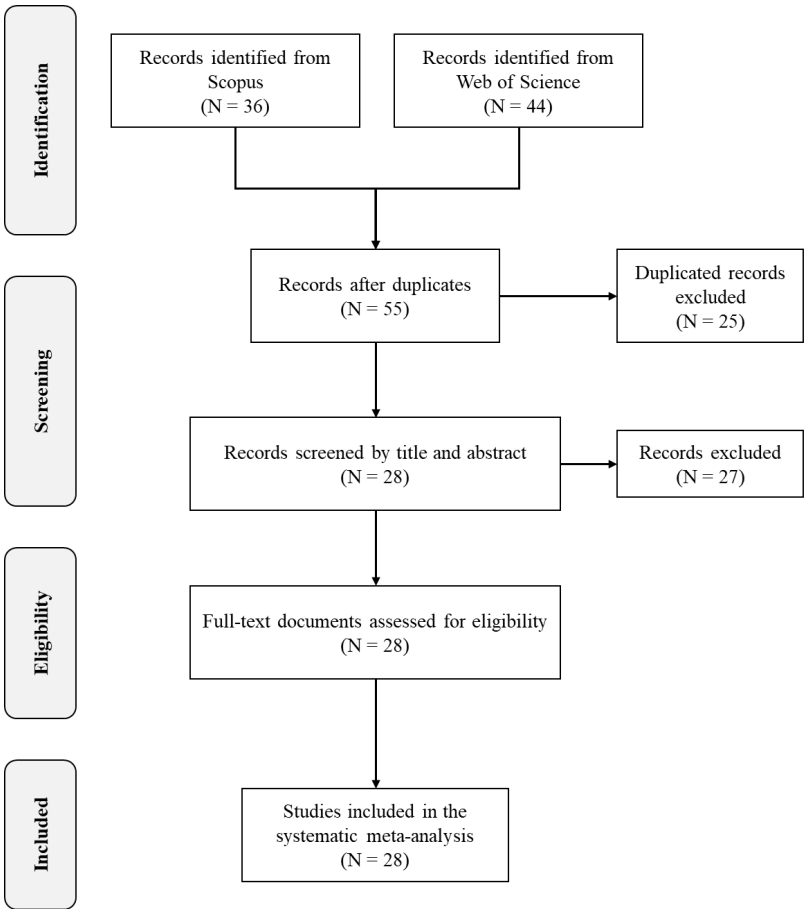

Figure 1 PRISMA workflow diagram
(Source: Authors' self-elaboration according to Page *et al.*, (2021))

Adhering to the purpose of this study, the bibliographic metadata was imported and analyzed in the Biblioshiny app of RStudio (Aria and Cuccurullo, 2017) and accompanied by Microsoft Excel to assist in recording and editing the primary analytic results obtained from Biblioshiny. Systematic bibliometric performance analyses along with several science mapping techniques in this research field were conducted through the following aspects: the development trend of scientific documents, the performance of countries by the number of publications, the collaborative networks across countries and authors, insights from cited references and citations of publications, and thematic analysis by keyword co-occurrence network.

■3.0 RESULTS AND FINDINGS

The results and findings of this study offer a detailed analysis of the knowledge structure of ESG in real estate. This section presents a detailed analysis of the trends in literature development, the patterns in cited references and citations, and the key insights derived from these trends to understand the evolution and impact of ESG research in the real estate sector.

3.1 Trend of Literature Development

As of the date of data extraction on April 15, 2023, a total of 28 published scientific documents were identified from Scopus and the Web of Science and included in the following bibliometric analyses, including 23 articles, 3 book chapters, and 2 review articles (see Table 1). These publications were contributed by a total of 62 authors, and their time span was from 2008 to 2023 (including early-access publications) with an annual growth rate of 4.73%. Two distinct growth tendencies can be observed in Figure 2: from 2008 to 2018, in a scattered growth trend in which one article each was produced in 2008, 2010, and 2014, and two in 2015; and from 2018 to 2023, in an intensive growth trend, peaking at 10 publications in 2022.

Table 1 Descriptive statistics of bibliographic metadata

Description	Results
Timespan	2008:2023
Annual growth rate (%)	4.73
Document average age	3.29
Scientific sources (journals, books, etc.)	21
Documents	28
Article (including early-access articles)	23
Book chapter	3
Review	2
Authors	62
Authors of single-authored documents	7
Co-authors per document	2.46
International co-authorships (%)	28.57
Document contents	
Keywords plus	62
Author's keywords	115
References	1085

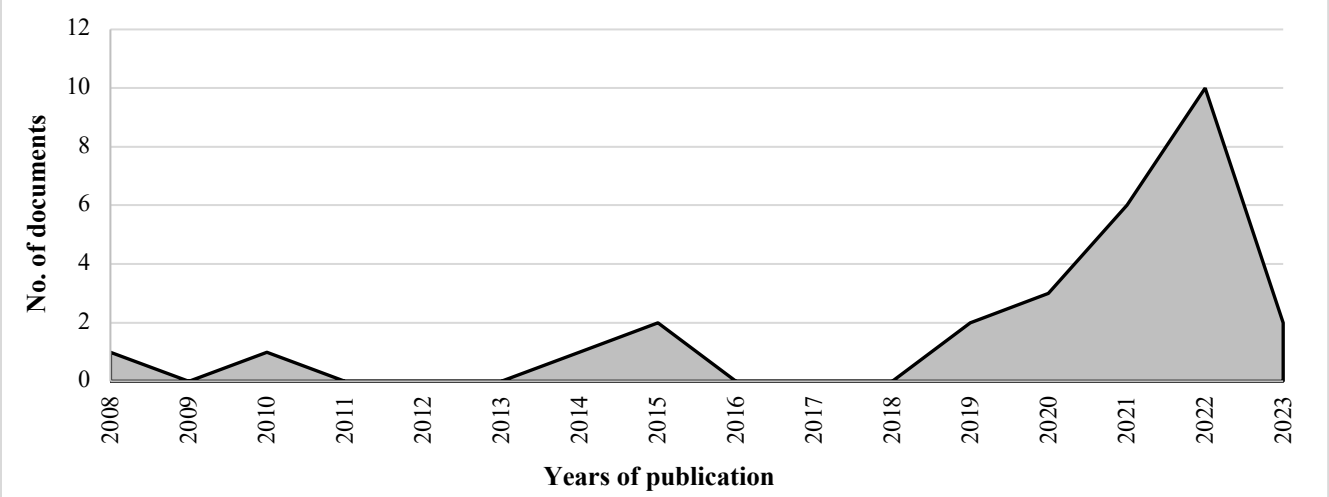

Figure 2 Growth trend of scientific documents of ESG in the real estate literature
(Source: author)

3.2 Performance of Countries and Collaborative Network across Countries and Authors

In this study, the performance of countries was evaluated by viewing the occurrences of the countries where affiliations of authors are located, that also refers to the part of the co-authorship analysis in bibliometric analysis (Aria and Cuccurullo, 2017; Cobo et al., 2011a). As shown in Figure 3, a total of 13 countries were involved in this research field, with Canada and the United States leading the way, with 11 publications having authors from Canada and 9 publications having authors from the United States. This was followed by six publications each from Australia and the United Kingdom, and five publications each from Belgium and the Netherlands. In addition, it was evident that among all the contributing countries, there was only one publication from a developing country (i.e., China), while the others were mostly English-speaking countries (i.e., Canada, USA, Australia, UK, New Zealand, Singapore) and European countries (i.e., Belgium, Germany, Italy, Switzerland, Spain).

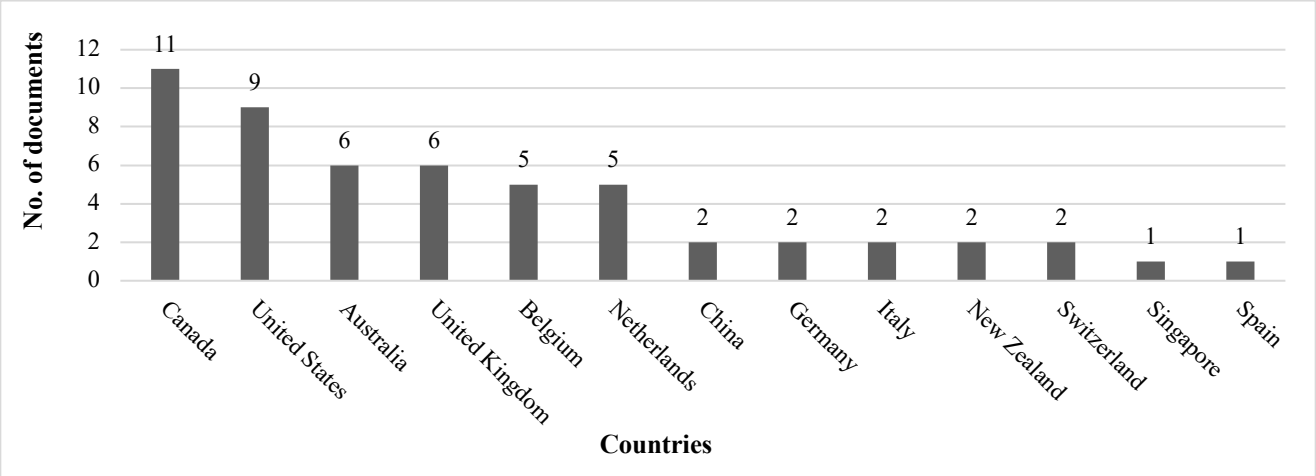

Figure 3 Number of publications by countries
(Source: Author)

International collaboration occurs when the co-authors of an article come from affiliated institutions located in at least two different countries, that are considered to be part of a scientific community in a related research field, through which knowledge is exchanged and recognized (Kwiek, 2020). Relevant real estate literature specializing in ESG studies had a considerable international collaboration network. As shown in Figure 4, Canada had the closest collaboration with other countries, with five collaboration networks, followed by the United States, where there were three networks of collaboration.

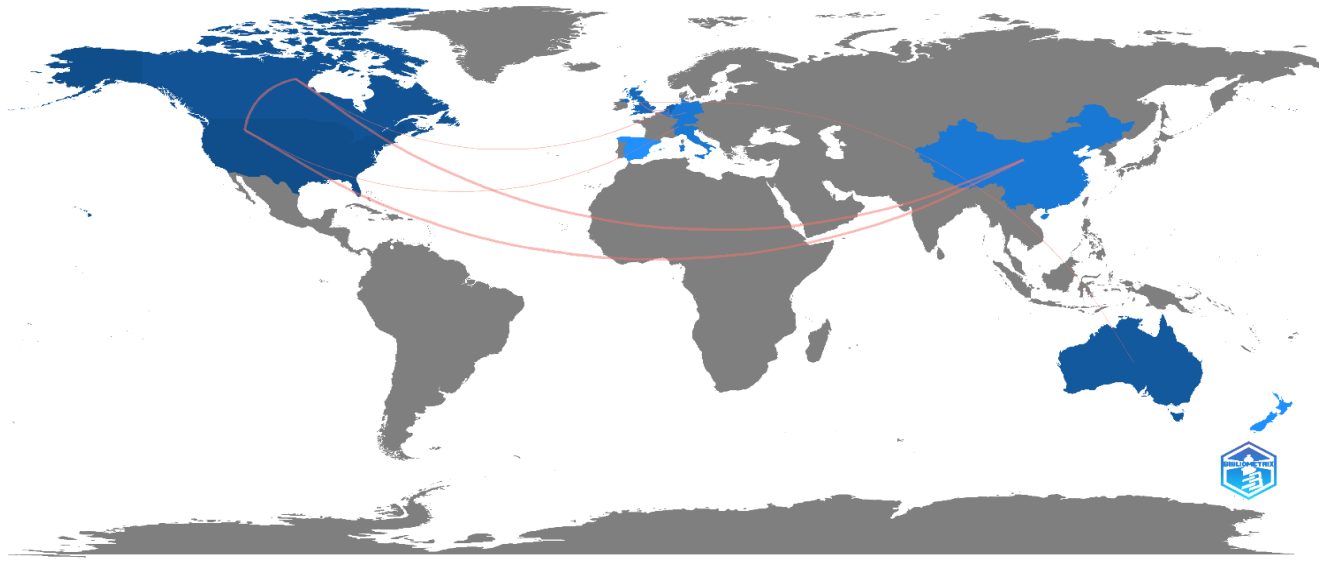

Figure 4 World collaboration map
(Source: authors' self-elaboration through Biblioshiny. Note(s): Direction of cross-country collaborations: From Canada to China (2), and to the United States (2), and to the Netherlands (1); from the United States to China (2), and to Switzerland (1); from the United Kingdom to Germany (1), and to the Netherlands (1); from Australia to the United Kingdom (1); and from Belgium to the Netherlands.)

Each node represents an author, and the lines connecting the nodes indicate that the authors have collaborated with each other, with the same color indicating that they have collaborated on the same article (Han et al., 2014). The more collaborations between authors, the thicker the line is, and similarly, the larger the size of the node, the more the author has contributed. There was a total of 16 groups of author collaboration networks (see Figure 5), the most prominent of which were the collaboration network composed of Newell G., Marzuki M., and Nanda A.; and the collaboration network consisting of Compernolle T. and Peeters M., making them the most productive authors in the extant literature of our research field (see Table 2).

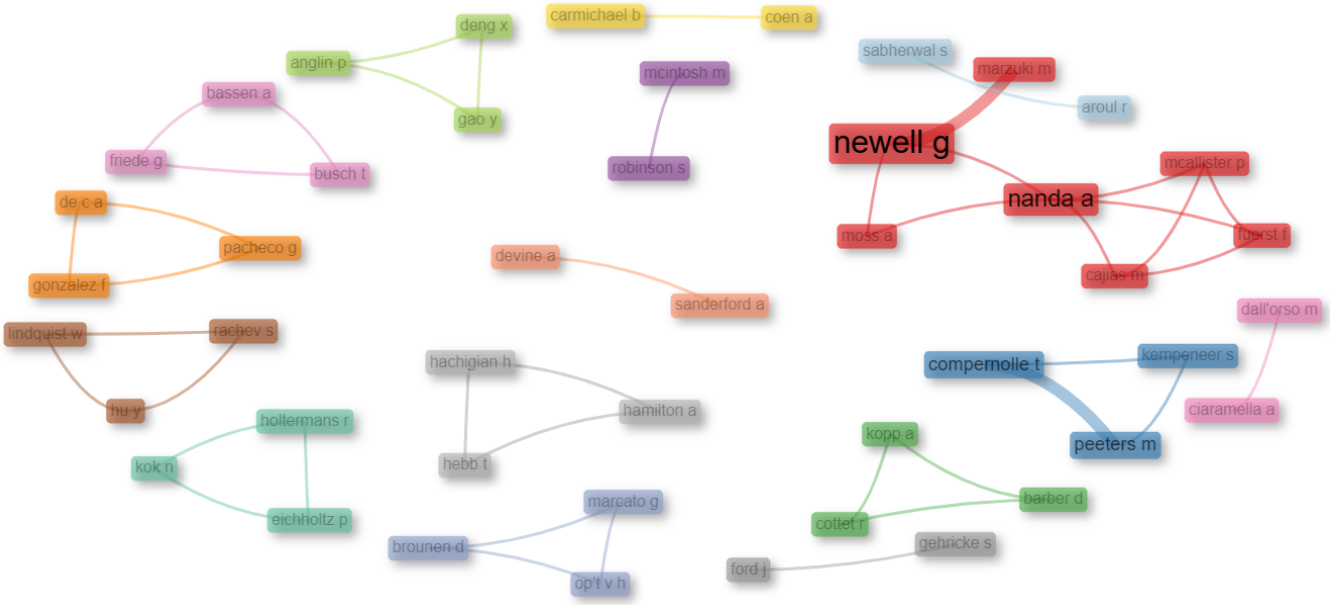

Figure 5 Authors' collaborative network
(Source: authors' self-elaboration through Biblioshiny)

Table 2 Top five most productive authors

Authors	Documents	Fractionalized No. of Documents	No
Newell G.	(Marzuki and Newell, 2019; Newell, 2023; Newell et al., 2023; Newell and Marzuki, 2022)	2.33	4
Marzuki M.	(Marzuki and Newell, 2019; Newell and Marzuki, 2022)	1.00	2
Compernolle T.	(Kempeneer et al., 2021; Peeters et al., 2021)	0.67	2
Peeters M.	(Kempeneer et al., 2021; Peeters et al., 2021)	0.67	2
Nanda A.	(Cajias et al., 2014; Newell et al., 2023)	0.58	2

3.3 Trends of Cited References and Citations

The trends of cited references and citations of publications are consulted to explore the origins (or theoretical fundamentals) and development of the designated research field, and bibliographic techniques such as reference publication year spectroscopy (RPYS) and bibliographic mapping of co-citation networks are employed. RPYS is based on the analysis of the cited frequency of publications in a specific research field and the correlative publication year of the cited references, and the origins are visible as more or less obvious trend peaks, which are mostly driven by certain articles that are cited repeatedly (Marx et al., 2014; Thor et al., 2016). Furthermore, the bibliographic mapping of co-citations, or co-citation network, allows a graphical representation of the research field by visualizing and identifying relationships or links when two publications reference a common third article in their bibliographies, indicating that a probability exists that the two articles treat related subject matter (Ferreira, 2018; Kessler, 1963). In this study, the co-citation network analysis was performed in the Biblioshiny app running the "walktrap" clustering algorithm with a minimum number of two edges.

According to Figure 6, four distinct trends were drawn: 1) Citations of relevant literature can be traced back to 1957 at the earliest, and the average annal frequency of cited references published between 1957 and 1999 was less than 10 times. 2) From 1999 to 2008 was the second growth interval, where the literature published in 2007 had the highest citation frequency of 35 times in this interval, followed by 31 times in 2005. 3) From 2008 to 2016 was the third growth interval, where the two peaks appeared in 2011 and 2014, each being cited 47 times in the literature. 4) The number of cited references fell to its lowest value in 2016 since 2005 (25 cited references), and from 2016 onwards, the edge showed a sharply increasing trend to reach the peak of 78 references in 2019.

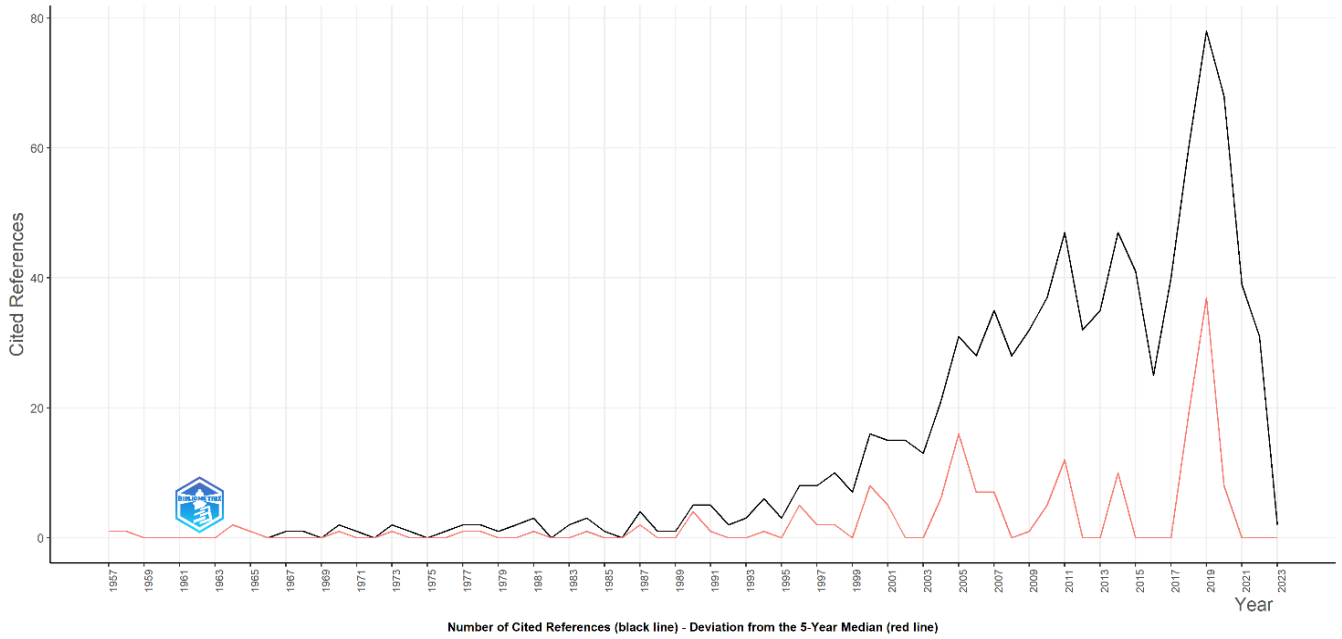

Figure 6 Reference publication year spectroscopy (RPYS)
(Source: author's self-elaboration through Biblioshiny)

The co-citation bibliographic mapping shown in Figure 7 presented 13 clusters composed of 40 references that have been cited at least twice in the retrieved bibliographic databases, and three relatively significant bibliographic citation clusters were observed. The first cluster contains 18 cited documents, of which 6 were published from 2008 to 2016, and 12 were published from 2016 to 2022, among which the most influential work was contributed by Eichholtz et al. (2010), which formed the core of this cluster with publications demonstrated by Fuerst (Fuerst and McAllister, 2011c, 2011a), Warren-Myers (Warren-Myers, 2022; Warren-Myers et al., 2020a, 2020b), and Newell et al. (2014). The second cluster consists of An et al. (2011), Coën et al. (2018), Eichholtz et al. (2012), and Fuerst and McAllister (2011b). It is worth noting that this cluster has the highest average number of citations in all applied literature and has a great influence on the research and development of theory. The third notable cluster consists of six documents, the core of which are Beracha et al. (2019) and Eichholtz et al. (2013).

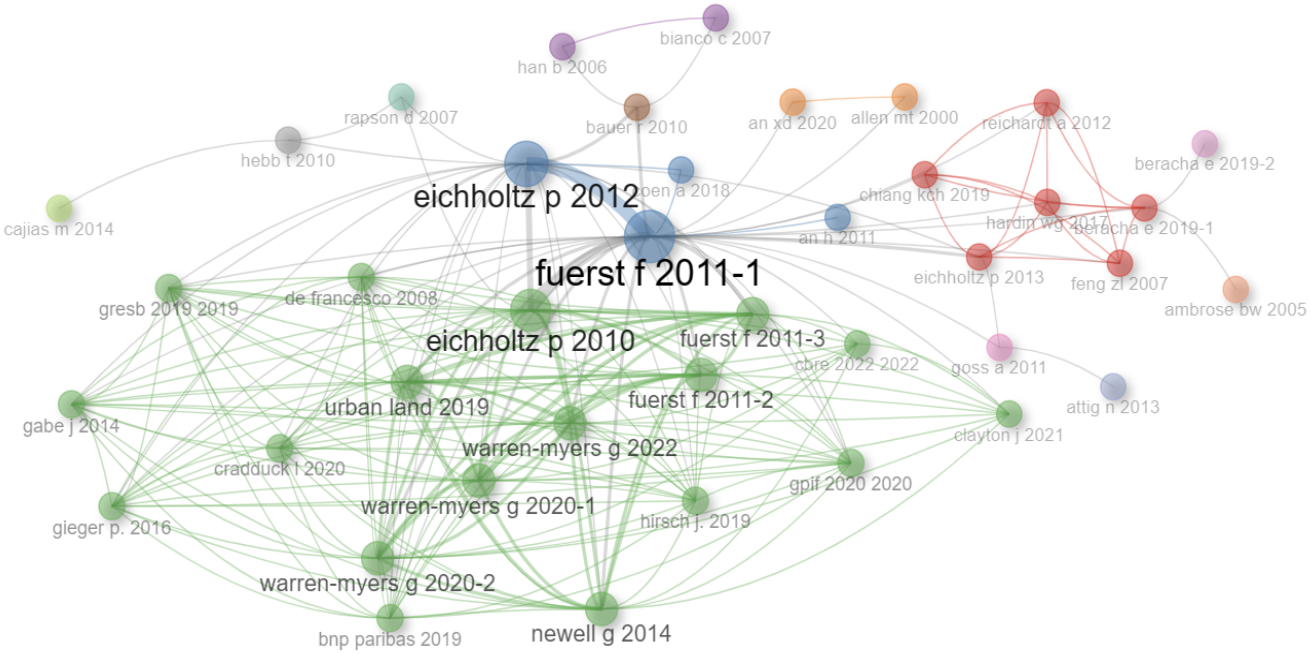

Figure 7 Co-citation network
(Source: author's self-elaboration through Biblioshiny)

Marchiori and Franco (2020) argued that the knowledge sharing process is complete through knowledge transferring or propagating from individuals or communities to another, and links of citations driven by authors offer a specific view of the intellectual structure of a research field. Figure 8 and Figure 9 presented the most cited publications global-wide and local-wide (among the retrieved bibliographic databases), respectively, in the relevant real estate literature focusing on ESG studies, with Friede et al. (2015) article published in the *Journal of Sustainable Finance and Investment* having the significantly highest global citation frequency with 734 citations. Following Eichholtz et al. (2019), published in the *Journal of Banking and Finance*, and Hebb et al. (2010), published in the *Journal of Business Ethics*, each was cited 31 times. Articles published by Pivo (2008) in the *Journal of Property Investment and Finance*, Cajias et al. (2014) in the *International Journal of Strategic Property Management*, Feng and Wu (2021) in the *Journal of Real Estate Finance and Economics*, and Marzuki and Newell (2019) in the *Journal of Property Investment and Finance* were cited globally more than five times in the research field. Comparatively, there were seven articles cited 11 times locally among the 28 publications, which were led by Hebb et al. (2010) (3 times), Cajias et al. (2014) (2 times), and Newell et al. (2014) (2 times).

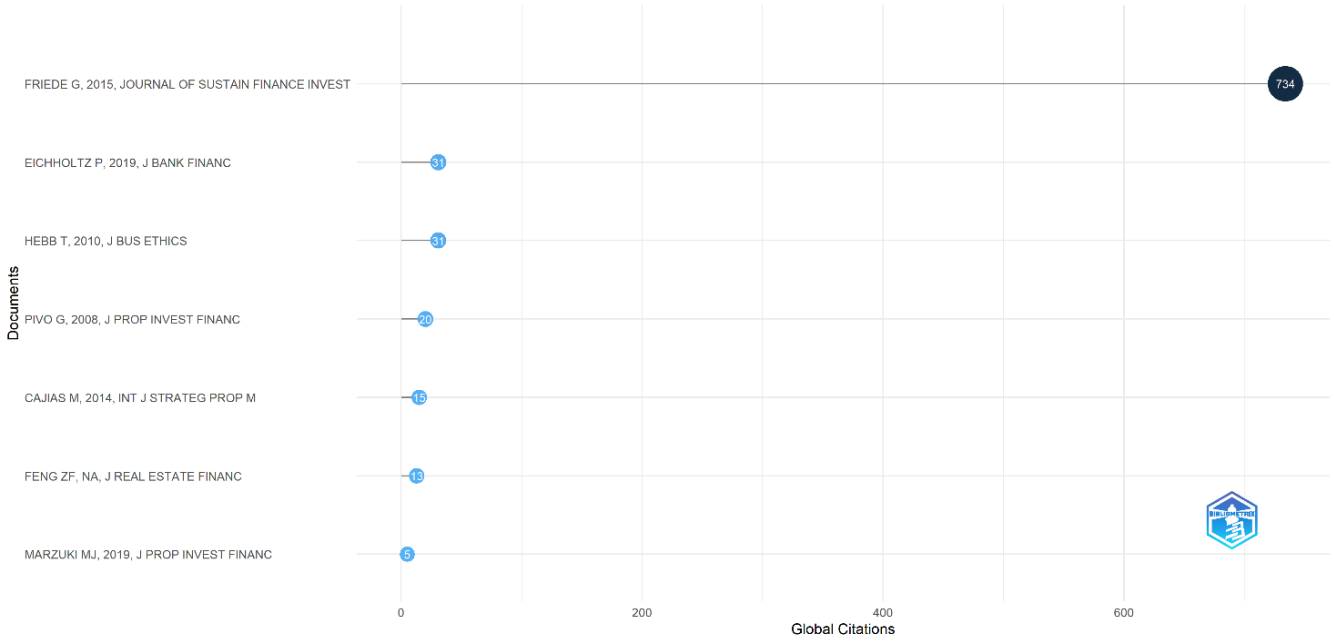

Figure 8 Most global cited documents
(Source: authors' self-elaboration through Biblioshiny)

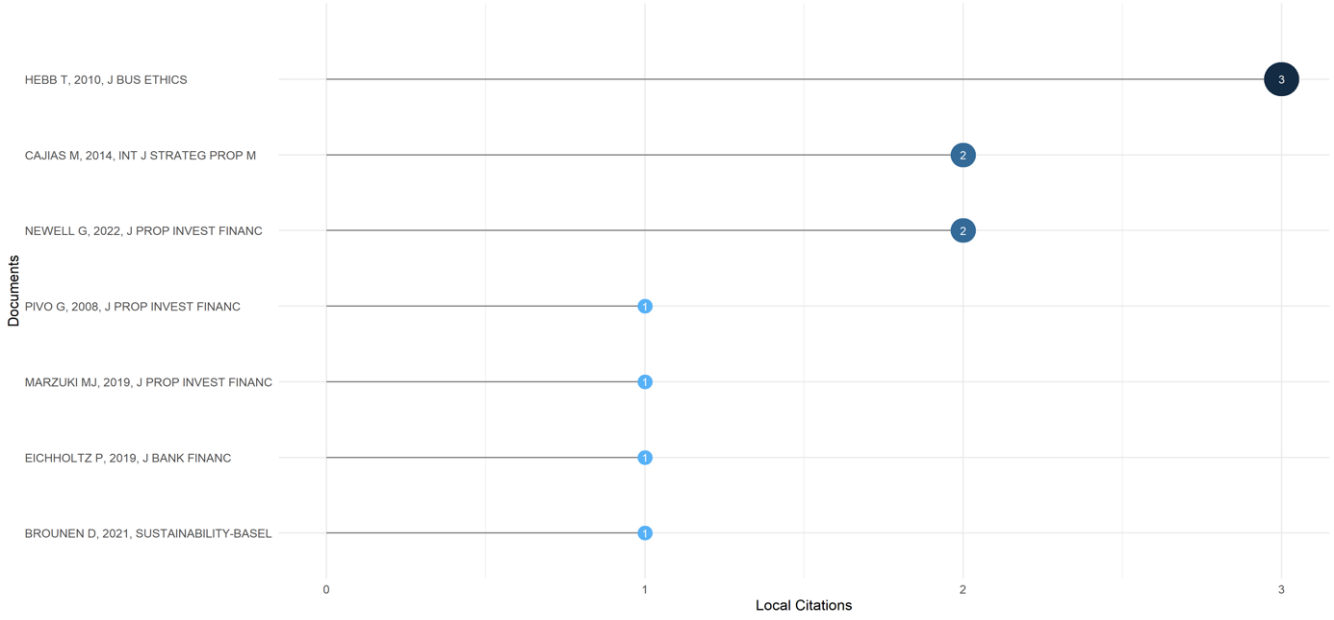

Figure 9 Most local cited documents
(Source: authors' self-elaboration through Biblioshiny)

3.4 Trends of Cited References and Citations

The co-occurrence network utilizing Keywords Plus is shown in Figure 10. The clusters presented in the figure show groupings of textual data through co-word analysis and are seen as thematic clusters addressed in the research field (Cobo et al., 2011b). Keywords Plus are automatically generated by computer algorithms (Garfield and Sher, 1993), and contain both the most frequent words or phrases in the titles of cited references and the author's keywords, which are regarded as more thorough than using the author's keywords when employed to exhibit the research tendency and map the knowledge structure of a specific research field (Zhang et al., 2016).

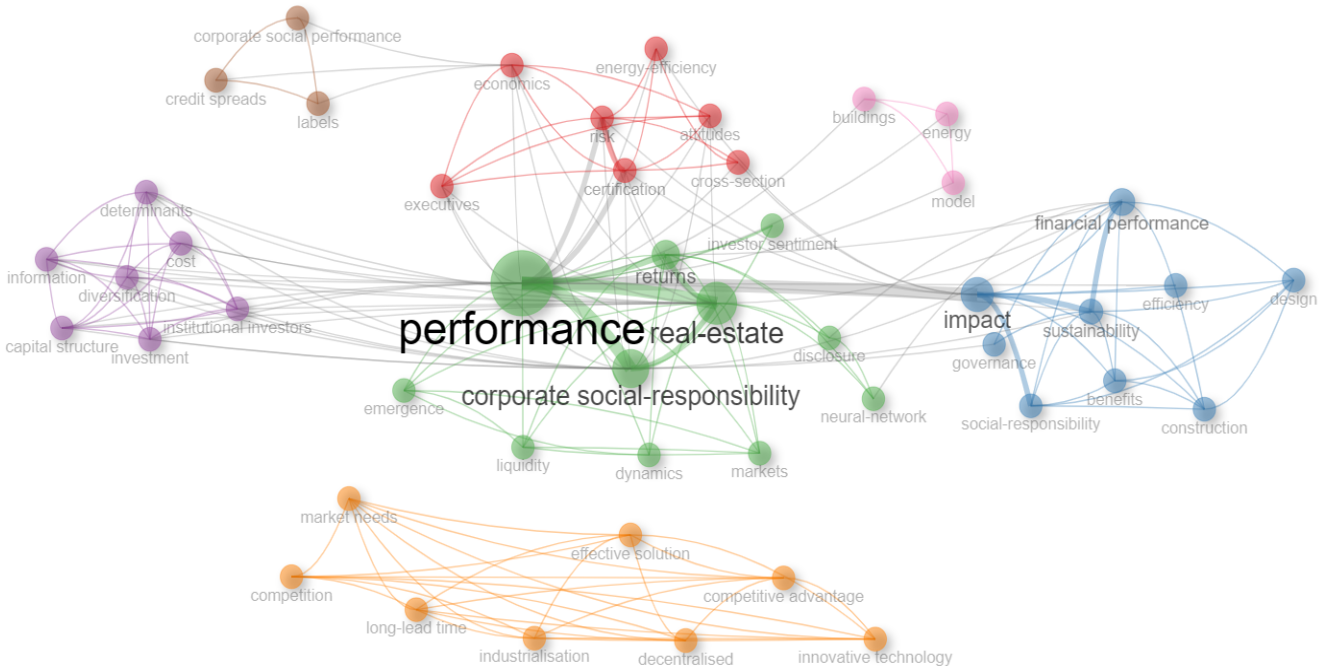

Figure 10 Co-occurrence network by Keywords Plus
(Source: author's self-elaboration through Biblioshiny)

It is observed in Figure 10 that there are seven thematic clusters in total, of which **Cluster I** is the core theme, consisting of ten keywords such as 'performance,' 'real-estate,' 'corporate social-responsibility,' 'returns,' 'disclosure,' 'dynamics,' 'emergence,' 'investor sentiment,' 'liquidity,' 'markets,' and 'neural network,' and is closely interconnected and cross-referenced with the other five thematic clusters, with Ford et al. (2022), Marzuki and Newell (2019), and Siew (2015) making more prominent contributions to the study of the theme.

Cluster II consists of nine keywords: 'impact,' 'financial performance,' 'sustainability,' 'social responsibility,' 'benefits,' 'construction,' 'design,' 'efficiency,' and 'governance.' This thematic cluster has been the most extensively studied in terms of relevant publications, with Cajias et al. (2014) and Kempeneer et al. (2021) being more focused on this theme, and Deng et al. (2021), Devine et al. (2022), Newell et al. (2023), Newell and Marzuki (2022), and Zanin (2022) being partially related to it.

Cluster III was driven by the studies of Deng et al. (2021) and Devine et al. (2022) and is formed with seven keywords, including 'economics,' 'certification,' 'risk,' 'attitudes,' 'cross-section,' 'energy efficiency,' and 'executives.'

Cluster IV presents a homogeneous research tendency of a financial nature concerning the impact of ESG on real estate. Keywords such as 'capital structure,' 'cost,' 'determinants,' 'diversification,' 'information,' 'institutional investors,' and 'investment' were identified and highlighted by Feng and Wu (2021).

Cluster V and **Cluster VI** are at the edges of the research themes, and each contains three keywords. Cluster V was mainly studied by Peeters et al. (2021) and contained keywords such as 'buildings,' 'energy,' and 'model.' Cluster VI was mainly contributed by Eichholtz et al. (2019) and included research interests on 'corporate social performance,' 'credit spreads,' and 'labels.'

Cluster VII is relatively independent from the other thematic clusters, which consists of eight keywords such as 'competition,' 'competitive advantage,' 'decentralized,' 'effective solution,' 'industrialization,' 'innovative technology,' 'long-lead time,' and 'market needs,' and the research on this theme was mainly led by Ciaramella and Dall'Orso (2021).

■4.0 DISCUSSIONS

The findings of this study provide a comprehensive overview of the knowledge structure and development trends of ESG in the real estate sector. The bibliometric analysis reveals a growing body of literature focused on integrating ESG principles into real estate practices, highlighting both opportunities and challenges.

4.1 Implications of Findings

The integration of ESG factors across all lifecycle stages of real estate operations—such as due diligence, acquisitions, leasing, design, construction, and asset management—indicates the sector's commitment to sustainability and ethical practices. This reflects a broader shift towards more sustainable business models, driven by increasing regulatory requirements and market demands, as well as heightened awareness of environmental and social issues.

The emphasis on environmental impact, particularly in terms of waste management, energy consumption, and greenhouse gas emissions, is aligned with global efforts to combat climate change. These findings are consistent with previous studies by Newell et al. (2023) and Robinson and McIntosh (2022), which also highlight the positive environmental outcomes of ESG integration in real estate.

Our study corroborates existing literature by demonstrating that ESG performance metrics are becoming critical benchmarks for investors and stakeholders. This is in line with findings from Newell et al. (2023) and Kempeneer et al. (2021), who emphasize the increasing importance of ESG performance measurement in real estate investment decisions.

However, the study also identifies significant challenges, such as the lack of standardization in ESG reporting and the insufficiency of reliable data. These challenges have been previously noted by Eccles et al. (2017) and Feng and Wu (2021), suggesting that they remain persistent issues that need to be addressed to facilitate more effective ESG implementation.

4.2 Potential Research Limitations

Several limitations of this study should be noted. Firstly, the reliance on bibliometric methods means that contextual factors influencing ESG practices may not be fully captured. The analysis treated ESG as a precise, holistic concept and framework when querying and screening bibliographic databases. Consequently, literature that discussed only a single factor of ESG (e.g., the impact of the environment on real estate) or partially related aspects of ESG were excluded, which may have resulted in a narrower scope of the bibliometric analysis.

Additionally, the study was limited to literature indexed in Scopus and Web of Science. This restriction means that relevant studies, such as industrial reports and literature indexed in other databases like Google Scholar and PubMed, were not considered. This limitation could potentially omit significant contributions from the analysis.

■5.0 CONCLUSIONS

This study employed a bibliometric analysis following the guidance of the PRISMA workflow and made a central theoretical contribution to the research field of real estate-related ESG literature. By responding to the research questions, it clarified the current knowledge structure of the research field. Particularly, the following facts are highlighted:

1) Research in real estate literature addressing ESG can be traced back to as early as 2008, and after 10 years of discontinuous development, it began to show a gradual outbreak of intensive research and rapid growth in 2018.
2) Research from English-speaking countries (e.g., the United States, Canada, Australia) and European countries (e.g., Belgium, the Netherlands, Germany) dominated this research field, while research institutions from emerging economies and developing countries (e.g., China) were in a distinctly backward position.
3) Transnational collaboration and co-authorship were distinctive features in this research field, implying strong recognition by the international academic community and the possibility of future worldwide collaborative research.
4) A total of 1085 references were cited in 28 publications, and the earliest cited reference was published in the year 1957, and publications contributed by Eichholtz (Eichholtz et al., 2010, 2012, 2013, 2019), Fuerst (Fuerst & McAllister, 2011a, 2011b, 2011c), and Warren-Myers (Warren-Myers, 2022; Warren-Myers et al., 2020a, 2020b) were most cited by the local scholars. In addition, articles contributed by Friede et al. (2015) and Hebb et al. (2010) were notable as having the highest number of global citations and local citations, respectively.
5) According to the distribution and association of keywords, the themes of real estate-related literature on ESG relevance were divided into seven clusters. The core research theme consisted of ten keywords such as 'performance,' 'real-estate,' 'corporate social-responsibility,' 'returns,' 'disclosure,' 'dynamics,' 'emergence,' 'investor sentiment,' 'liquidity,' 'markets,' and 'neural network.' The thematic cluster containing 'competition,' 'competitive advantage,' 'decentralized,' 'effective solution,' 'industrialization,' 'innovative technology,' 'long-lead time,' and 'market needs' was relatively independent of the other six clusters and did not show any interconnection or cross-reference.

In summary, ESG is a novel and essential framework for real estate research, becoming increasingly vital for all stakeholders in the industry. This comprehensive study stands out due to its summative nature, and the following recommendations are given for both academia and industry for future development:

- Technologies such as PropTech and smart building systems hold significant potential for advancing ESG goals. Investigating how these technologies can be leveraged to enhance sustainability and operational efficiency is crucial. Understanding their

impact will enable better integration of technological innovations into ESG strategies, driving further progress in the real estate sector.

- Real estate professionals can significantly benefit from integrating ESG considerations into their decision-making processes. Embedding ESG factors throughout all stages of operations—from due diligence to asset management—optimizes operational efficiency and aligns strategies with global sustainability trends. This holistic approach not only enhances strategic planning but also strengthens risk management by proactively addressing potential ESG-related challenges.
- For investors, the identified ESG metrics offer valuable tools for assessing the sustainability and ethical performance of real estate assets. Developing standardized metrics tailored to the specific needs of the real estate sector is essential. These metrics should capture unique operational characteristics, allowing for more accurate benchmarking and performance evaluation. Establishing common criteria for ESG assessment ensures greater consistency and comparability across the industry.
- Real estate companies adopting the best practices highlighted in this study can significantly contribute to broader sustainability goals. Focusing on reducing greenhouse gas emissions and promoting sustainable urbanization benefits the environment and enhances the social and economic value of their assets. Implementing these practices positions companies as leaders in sustainability, driving positive change within the industry and the communities they serve.
- Lastly, this research suggests the need for further longitudinal studies to gain deeper insights. The longitudinal method tracks changes and outcomes over time, revealing trends and long-term benefits that might not be immediately apparent.

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