# Synthesis on ESG performance and green innovation Based on Quantitative Methods-Bibliometrix R Package

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**Abstract.** In the context of UN Sustainable Develop Goals of 2030, the ESG performance and green innovation is an attracting field for not only scholars, but also managerial and governors. Yet few scholars have made contribution on synthesizing knowledges of this field. With assisting of R package Bibliometrix, this research employs mathematical method, which is the bibliometric analysis, to help give an insight of ESG performance and green innovation. Bibliometrics is the use of statistical analysis and quantitative methods to measure and analyze information within publications. It helps assess the impact, evaluate productivity, and understand trends in research and scholarly communication. A total of 77 articles were retrieved from WoS core collection. The results are visually represented as well as prosperous future research topics for academics diving into. The ESG performance and green innovation is currently in bursting stage. Ownership, financial constraints, incentives, sustainability, performance management, and economic growth is the motor theme, worthing dig into. The results may help scholars quickly understand this field and identify frontier. In addition, this research also provided a value reference for conducting bibliographic analysis in ESG performance and green innovation field as well as other scholar domains.

**Keywords:** ESG performance, green innovation, bibliometric

## 1 Introduction

The UN sustainable development goals 2030 calls for ensuring sustainable consumption and production patterns, and promoting sustained, inclusive, and sustainable economic growth, full and productive employment and decent work for all economic growth, full and productive employment and decent work for all [1], [2]. Enterprise plays a significant role in realizing these sustainable development goals. However, academics had contributed few to comprehensive understand this field and give a evidence -based review in to this field. The traditional review emphasizes on empirical contributions rather than synthesis exiting research. This has led to a voluminous, fragmented, and contested field [3]. This research aims to apply science mapping and bibliometric methods to generate a comprehensive picture of ESG performance and green

innovation, helping scholars to understand this field quickly and identifying frontiers for dig into.

## 2     Methods and Data

This research employs bibliometric analysis [4], assisting by Bibliometrix R package [5], to reveal the conceptual, intellectual structure of ESG performance and green innovation. Bibliometrics is the use of statistical analysis and quantitative methods to measure and analyze information within publications. It helps assess the impact, evaluate productivity, and understand trends in research and scholarly communication. Bibliometrix is an R package that can be used to perform bibliometric analysis and visualization. In the first place, descriptive analysis is represented by statistic, which reveal basic information and statistical characteristics of data collection. Corpus data is retrieved from the Web of Science, which is the oldest citation database with the longest coverage on both bibliographic data and citation data. The search strategy is [6] TOPIC:(ESG performance) AND (green innovation); DOCUMENT TYES:(Article); LANGUAGE:(English); INDEX:(WoS Core collection). Article bibliographic information is exported and saved into "Bibtex" format. Totally 77 articles are retrieved, and time span covers 2010-2023. Rajesh R is the most cited author.

## 3     Result

**Fig 1** shows scientific article development trend in ESG performance and green innovation field from 2010 – 2030. The first article was published in 2010, yet, in the first 10 years, annul production of 8 years were 0. This indicates that the concept of ESG performance and green Innovation appeared in 2010, however it hasn't received much attention. However, it noticed that the annual production was burst from 2020.
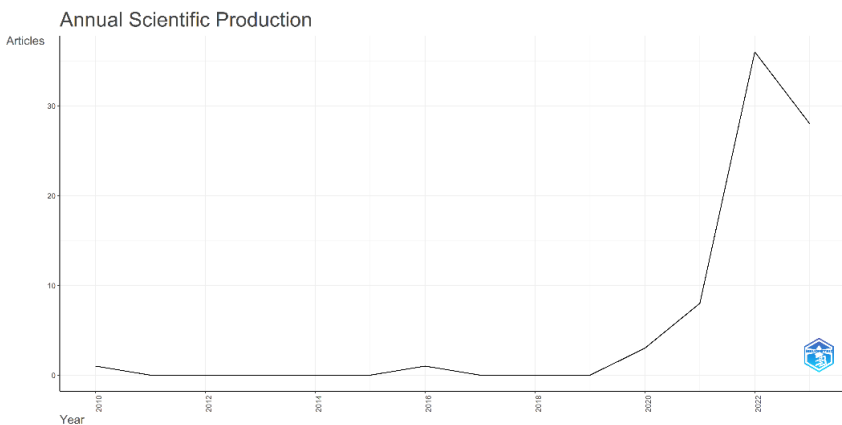


**Fig. 1.** Annual scientific production in ESG performance and green innovation field

For author performance, 219 authors are involved. This study measures author impact with Total Citation (TC). The top 10 highly cited authors are shown in Table 1. All highly cited author starts publish paper around 2021. Thus, article production of each of them is only 1-2 papers. Rajesh R is the most cited author, published 1 paper, been cited 80. Notably, only 2 authors out of 10 are from China, which indicates that foreign scholars are advance to scholars of China in the field of ESG performance and green innovation. In an overview, ESG performance and green innovation field burst in 2020, not too many authors are highly productive. Published papers have received frequent citations. This indicates this field is attracting wide interests.

**Table 1.** Authors performance

| Authors | h_index | TC | NP | PY_start |
|---|---|---|---|---|
| RAJESH R | 1 | 80 | 1 | 2020 |
| FUJII H | 1 | 74 | 1 | 2021 |
| KEELEY S | 1 | 74 | 1 | 2021 |
| TOLLIVER C | 1 | 74 | 1 | 2021 |
| CHOUAIBI J | 2 | 65 | 2 | 2021 |
| CHOUAIBI S | 2 | 65 | 2 | 2021 |
| ROSSI M | 1 | 60 | 1 | 2022 |
| TAN Y | 1 | 54 | 1 | 2022 |
| ZHU Z | 1 | 54 | 1 | 2022 |
| MURDOCK BE | 1 | 53 | 1 | 2021 |

In term of frequently cited papers, as shown in Table 2. Given a paper that has been hi5g6hly cited, indicating it has been critically and repeatedly reviewed by peers. This paper may provide a solid basis for this field or propose an attracting future research direction. Thus, analysis on frequently cited article can help understand fundamental parts of ESG performance and innovation, as well as identify further research directions. This study measures highly cited papers by total citations which means that counting the number of citations a paper has received from other papers in whole database (here refers to WoS).

**Table 2.** Highly cited papers

| Paper | DOI | Total Citations |
|---|---|---|
| RAJESH R, 2020, J CLEAN PROD | 10.1016/j.jclepro.2019.119600 | 80 |
| TOLLIVER C, 2021, ASIAN ECON POLICY REV | 10.1111/aepr.12320 | 74 |
| CHOUAIBI S, 2022, EUROMED J BUS | 10.1108/EMJB-09-2020-0101 | 60 |
| TAN Y, 2022, TECHNOL SOC | 10.1016/j.techsoc.2022.101906 | 54 |

| MURDOCK BE, 2021, ADV ENERGY MATER | 10.1002/aenm.202102028 | 53 |
|---|---|---|
| XU J, 2021, KYBERNETES | 10.1108/K-12-2019-0793 | 36 |
| ZHENG M, 2023, BUS STRATEG ENVIRON | 10.1002/bse.3211 | 36 |
| ISAKSSON LE, 2016, J BUS RES | 10.1016/j.jbusres.2016.02.021 | 34 |
| HOANG THV, 2020, BUS STRATEG ENVIRON | 10.1002/bse.2437 | 32 |
| ZHANG F, 2020, SUSTAINABILITY | 10.3390/su12051866 | 30 |

Thematic maps based on the keywords extracted from publications. Here are the basic steps of how it creates a thematic map:1. It extracts keywords from the publications of interest (papers, patents, reports, etc.). The keywords represent the main topics or themes of those publications. Then the frequency of each keyword is calculated, that is, how many times that keyword appears. The more frequent a keyword is, the more important the corresponding theme is. Further, it calculates the similarity between different keywords based on their co-occurrence within the same publications. Closely related keywords will appear together more often. Using these frequencies and similarities, it clusters the keywords into groups of related themes. Each cluster represents a research topic or subfield within the domain. It plots the clusters on a two-dimensional map, arranging them based on their similarities. Closer clusters represent more related themes, while distant clusters are more distinct topics. It labels each cluster with the most representative keywords to indicate what that theme or topic is about. The size of a cluster's label is proportional to the number of publications assigned to that cluster. The resulting thematic map provides an overview of the main topics, how they are structured, and their relative importance within the body of publications analyzed. The map can then be analyzed to identify emerging trends, shifting themes, areas of growth or decline, and the relationships between different research strands.

In summary, a Bibliometrix thematic map generates a visual representation of the key themes within a domain based on keyword co-occurrence and frequency, providing insight into the conceptual landscape and evolution of that research area. This research applied thematic analysis on keyword plus to generate a thematic map of ESG performance and green innovation, which helps explore future research directions. As shown in Fig.2., all research themes derived from analyzed data collection are distribute according to its density and centrality in a X-Y axis system. The centrality measures the degree of interaction between themes. The density measures the internal connection strength of theme [7]. The first quadrant (upper-right quadrant) is the motor themes, on which scholars should focus. These themes are important and need to be further explore. Themes are in other three quadrants are not worth for further dig into.
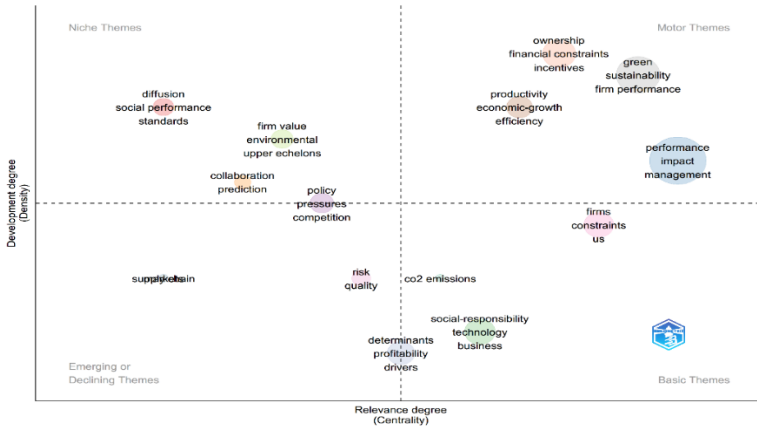
**Fig. 2.** Thematic map

## 4     Discussion and conclusions

The ESG performance and green innovation is currently in a rapidly expanding stage. This indicates that sustainable issue in enterprise development constantly attracted interest of academics to make contribution in this field. China, United Kingdom, and Italy are the most productive countries. China, India, and Japan are the most cited counties.

This paper reveals a comprehensive picture of research development in ESG performance and green innovation. This bibliometric literature review finds that:

More companies are adopting ESG principles and practices. ESG issues are gaining increasing attention from businesses, investors, and other stakeholders. More companies are reporting on their ESG performance and implementing ESG strategies. Renewable energy sources are expanding rapidly. The cost of renewable energy, especially solar and wind power, has fallen sharply. Many companies are investing heavily in renewable energy projects for their own operations or to provide green solutions for customers. Green investments and financing are on the rise. More funding is available for green technologies, businesses, and projects. Financial institutions are developing green bonds, loans, and investment products to channel capital towards sustainability. Energy efficiency and waste reduction efforts are paying off. Many companies have achieved significant reductions in carbon emissions, water use, waste generation and material inputs through efficiency improvements, process changes and recycling programs. Green product innovation is growing. More companies are developing sustainable products that minimize environmental impact, use eco-friendly materials, or provide environmental benefits during use. Examples include green buildings, electric vehicles, biodegradable plastics, and renewable energy technologies. Advances in clean technologies. There have been breakthroughs in technologies like carbon capture and storage, green chemicals, sustainable aviation fuels, next-generation batteries and others that can enable further progress towards decarbonization and a circular economy. Strengthening transparency and reporting. Improved disclosure of ESG performance data and impacts through frameworks like GRI, CDP, SASB, TCFD and others enable

better tracking, benchmarking, and management of ESG issues.The result shows the state-of-the-art of ESG performance and green innovation. We believe that this paper is helpful in following in two aspects:To help newly arrived scholars to quickly understand current research and identify frontiers; To enhance traditional literature review by introducing mathematical methods.

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