“Trends and research networks in greening business: A bibliometric analysis”

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TRENDS AND RESEARCH NETWORKS IN GREENING BUSINESS: A BIBLIOMETRIC ANALYSIS

Abstract

Business development contributes to the sustainable economic development of the country while also leading to significant environmental changes at the global level. The greening of businesses is becoming a priority area of strategic management for companies, considering the growing environmental challenges and the need to move toward sustainable business models. This study aims to identify the historical, evolutionary, spatial, and conceptually scientific landscape of greening businesses through bibliometric analysis. The study analyzed 660 sources in the Scopus database from 1992 to 2024. The use of VOS Viewer software and the Scopus analysis tool has shown that greening business research has been of interest among many authors and is a growing trend. The rapid growth of publications from 2019 to 2024 shows its significance to many government agencies, business people, investors, and researchers. The growing number of scientific studies in economics, management, and ecology indicates a growing scientific focus on the problems of greening businesses. The United States occupies a leading position in research volume, while the United Kingdom and China emphasize their significant contribution to developing this concept. A comprehensive analysis of scientific publications identified seven key clusters reflecting the directions of modernization of environmental business. These include green technologies, green finance, and an economy focused on the environmental transformation of businesses. The dynamics of publication activity in these fields of science confirm the relevance of the concept of eco-friendly business and its significant potential for further scientific research and practical implementation.

Keywords environment, green economy, technology, strategies, business performance, entrepreneurship, safety, sustainable development

JEL Classification Q50, Q57, M14, M21

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INTRODUCTION

Greening business is becoming an integral part of the modern economic agenda in the context of global environmental issues such as climate change, depletion of natural resources, and ecosystem degradation. This is evidenced by the Sustainable Development Goals, which aim to improve the well-being and protection of the planet (Gallana et al., 2013; Guterres, 2019). In the industrial era of the world's development, companies that cause irreparable environmental damage are one of the main pollution factors. In this regard, greening the business will relieve the environmental impact. According to the United Nations Environment Programme, the "green" economy and the greening of business are closely interrelated, including reducing greenhouse gas emissions, efficient use of resources, introducing environmentally friendly technologies, and ensuring social responsibility.

The term "greening business" has no established author or date of first use. However, according to a summary of UN documents, greening a

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business is the process of integrating environmentally sustainable principles and practices into a company's activities to minimize its negative impact on the environment. The concept of sustainable development and environmental responsibility of business began to develop actively in the 1980s. In 1987, the World Commission on Environment and Development published the report "Our Common Future" (also known as the Brundtland Report) (Brundtland, 1987), which defines sustainable development as "meeting the needs of the present without compromising the ability of future generations to meet their own needs." This report has played a key role in shaping modern ideas about business environmental responsibility. In addition, the relevance of greening business is closely related to environmental marketing. Companies implementing eco-friendly marketing benefit from increasing consumer confidence, improving their reputation, and implementing innovative business models based on sustainable consumption and responsible production principles. According to Ottman (2007) and Peattie and Charter (2016), using environmentally oriented strategies reduces the negative impact on the environment and increases the competitiveness of enterprises. Due to global environmental changes and business development in recent decades, there has been an increased interest in scientific research on various aspects of greening business. These articles cover various disciplines, such as the environment, economics, and public administration, and demonstrate the breadth of the research field (from developing an environmentally friendly business to reducing the impact of pollution on the environment, including humans).

1. LITERATURE REVIEW

Greening businesses have become central to the global sustainable development agenda in recent decades. Changes in the surrounding environment led to environmental problems such as climate change, ecosystem degradation, air and water pollution, etc. Accordingly, society should seem to reduce the impact of business on the environment and decrease environmental interference. Thus, there is a tendency among business entities to transform work processes using the principles of sustainable development. Companies' environmental responsibility is increasingly perceived as an ethical obligation and a source of competitive advantage (Harrison, 2009; Chuang & Huang, 2015, 2018; Kangalakova & Sabden, 2017; Liu et al., 2022). Thus, the growing demands of consumers and regulators contribute to the active development of environmental management, encouraging enterprises to integrate sustainable practices and green technologies into their strategies (Jabbour, 2010; Nurlanova et al., 2020).

Greening enterprises aim to create long-term values that will reduce the negative impact on the environment. These enterprises optimize waste by implementing the principles of circular economy and increasing supply chain efficiency (Fineman, 2000). Introducing innovative business strategies reduces environmental emissions and waste (Dong et al., 2021; Barbosa, 2022; Potkány et al., 2024; Al Halbusi et al., 2024). The circular economy serves as a tool for putting greening business into practice. The reuse of resources not only has a beneficial effect on the environment but also brings financial benefits. Working on this principle will also lead to certain benefits for a multinational company. This confirms the initiatives of the European Union called The "Green Deal," where companies implementing environmental projects can count on government support, including grants, tax incentives, and green bonds (Ziętara & Mirkowska, 2021; Rampi & Bisazza, 2023). Such initiatives will force enterprises to recycle waste and help them diversify their production range and improve their image.

Another important aspect of reducing waste and emissions by enterprises into the environment is the introduction of "green" technologies. The development and implementation of "green" technologies in production not only reduces the negative impact but also contributes to the involvement of enterprises in the research and development process and the development of innovations. The effectiveness of "green" technologies is beyond doubt; one can give an example of research by scientists who, using an experimental method, have shown how "green" technologies filter out and reduce gas emissions into the atmosphere (Kanojia & Patil,

2020). Using green technologies stimulates innovation, as technologies do not stand still and require constant improvement. Moreover, companies investing in environmental innovation are becoming less vulnerable to changes in the regulatory environment, such as introducing a carbon tax. The research shows the positive effect of introducing environmental points in tax legislation as a tool to reduce the burden on the environment (Ntombela et al., 2019; Yu, 2020; Timilsina, 2022; Annicchiarico et al., 2024). In addition, improvements in the regulatory framework foster eco-friendly habits and strengthen the reputation of the state, investors, partners, and consumers (Lee & Kwon, 2019; Widiatami et al., 2023). Thus, support for introducing green technologies improves the social responsibility of businesses and demonstrates the government's interest in improving the planet's ecology.

A sustainable supply chain is another important aspect of greening a business. The supply chain includes the selection of raw materials, the purchase and supply of raw materials, production, the introduction of green technologies, storage, and inventory management, transportation, the use of environmental energy processing, sales distribution, as well as delivery to the end customer, disposal, recycling and return of goods (Fahim & Mahadi, 2022; Mancini et al., 2024). Thus, every process, from idea to implementation, must be practical and thoughtful to reduce environmental damage. In the scientific community, using an eco-friendly product for production is becoming increasingly popular in the greening of business. Scientists note that the supply chain of processes using solar, wind, or other renewable energy sources helps reduce dependence on traditional fuels (Li & Hu, 2014; Fouladi & Al-Ansari, 2021; Montalbano et al., 2022; Rahmani & Goli, 2023). The trend is to use less toxic products and prefer more eco-friendly raw materials. Solar, wind, or other renewable energy sources are equally widespread, which helps reduce dependence on traditional fuels (Van Hoek, 2001; Weber et al., 2002; Rahman & Hassan, 2024; Dogan et al., 2024). Thus, instead of using hydrocarbon-based fuels that emit carbon monoxide into the air, preference is given to renewable and non-waste fuels. Consumer awareness is formed under the influence of environmental education, awareness of climate issues, accessibility of "green" goods, and government environmental policy, which are also critical parts of greening business. Consumer awareness of the environmental aspects of products drives demand for environmentally friendly products (Kardos et al., 2019; Elgaaied-Gambier et al., 2022; Bimbo et al., 2021). This opens up prospects for studying the interaction mechanisms between businesses and consumers in the context of environmental responsibility.

Overall, greening a business is a complex and multifaceted process that combines economic, environmental, and social aspects. This scientific problem is so widespread that many researchers have conducted a systematic literature review and bibliometric analysis on various aspects of greening business (Cai & Guo, 2021; Chygryn & Miśkiewicz, 2022; Ofori et al., 2023). One of the first was Linnenluecke and Griffiths (2013), who studied business research on the relationship between firms, the environment, and society. At the same time, Akram et al. (2024) support the theory of accelerating the "green" growth of industries and the importance of introducing "green" financing by investing in ecology, climate change, and reducing carbon dioxide emissions. Gong et al. (2019) and Zhang and Zhao (2022) conducted a bibliometric analysis of the relationship between human capital and greening. Thus, this study aims to identify trends and scientific networks of greening business; namely, it shows countries concerned about the environment, identifies areas of science that will help reduce the negative effect, and also determines priority areas for combating environmental damage.

The purpose of this study is to systematize world scientific knowledge from 1992 to 2024 about the greening of business as an element of ecologically sustainable development, focused on the following areas:

1) the development of the evolution of scientific thought;

2) territorial distribution and concentration of research networks;

3) clustering of the thematic focus of research.

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2. METHOD

This paper is based on a bibliometric analysis assessing the formation of the concept of greening business in the scientific space. Bibliometric analysis is a method of analyzing large amounts of data that allows one to study the evolution of a subject and identify trends in scientific research and related fields. The tools used for data analysis are the Scopus analysis tool and VOSviewerv.1.6.19, which allow the creation and analysis of bibliometric maps (Ellegaard & Wallin, 2015; Kwiliński, 2023; Bahuguna et al., 2023; Kwiliński & Kardas, 2024). VOSviewer provides the ability to create visualization maps based on keywords and can also use keywords to link countries, authors, and citations (Van Eck & Waltman, 2010; Kangalakova et al., 2024). This study conducted a bibliometric analysis, which included a keyword search for publications, screening, and analysis of scientific networks for the keywords "greening" and "business." The search for keywords was performed in the Scopus database, and the analyzed period covered the period from 1992 to 2024. During the search, 979 documents were found. In addition, restrictions were imposed in the field of science, where only studies related to business, management, accounting, ecology, economics, econometrics, and finance were selected, and 660 documents were chosen (Figure 1).

This number of scientific papers includes both scientific and review articles, articles in conferences, and chapters in books that have been evaluated for their high quality and novelty. Analyzing the dynamics of the number of publications makes it possible to identify periods of active research growth and declining interest and assess the impact of external factors on scientific activity (Radicchi & Castellano, 2013). Analyzing scientific networks makes it possible to identify the leading authors, scientific centers, and countries most actively studying greening business problems. Keywords were used to analyze scientific networks. This contributes to the formation of scientific collaborations, the development of interdisciplinary research, and the prediction of future science directions. Cluster analysis helps to identify hidden patterns and interdisciplinary connections in scientific research and also contributes to the development of new scientific hypotheses (Wang & Kim, 2023). In addition, clustering across keyword networks allows researchers to navigate the scientific environment more effectively, find potential partners for collaboration, and develop strategic directions for further research. Thus, thanks to the chosen strategy, analysis, and visualization, this study aims to identify key trends and patterns in scientific research and be the basis for future scientific hypotheses, collaborations, and interdisciplinary research.

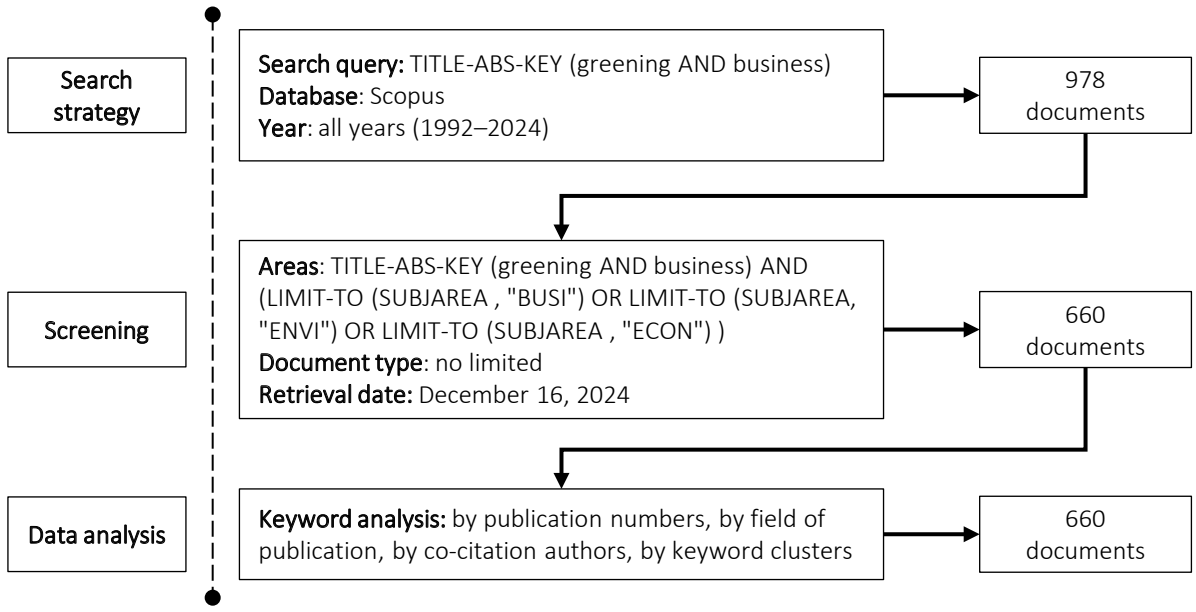

Figure 1. Data screening strategy

3. RESULTS

According to the data collected in the Scopus database, from 1992 to 2024, 660 publications on greening business were published (Figure 2). The dynamics of the publication are positive; significant growth occurred in 2019–2024. During this period, the UN Sustainable Development Goals were actively discussed, with the primary goal being to create a sustainable future for all. There is also an increase in the number of citations, with 1992 showing two citations, 2006 with 130 citations, 2016 with 1,099 citations, 2022 with 2,152 citations, and the peak in 2024 with 2,997 citations. The earliest study was conducted by Pinfield and Berner (1992), who focused on corporate governance and the environment by analyzing media materials. This article has been cited three times by Othman and Ameer (2009) and Maltby (1995). At the same time, the study was cited by Rizos et al. (2016) with 713 citations. This indicates that the problem of greening is urgent and is attracting increasing interest from scientists around the world.

Defining the scope of journals related to the greening of business helps business and scientific players navigate the scientific literature. In the field of knowledge, the largest share of research relates to business, management and accounting (24%), followed by environmental science (22%), social sciences (15%), economics, econometrics and finance (11%), engineering (7%), energy (6%), Earth and planetary sciences (3%), computer science (3%), decision sciences (3%), agricultural and biological sciences (2%). Such results show which areas of science are more concerned with running an eco-friendly business and which profitable corporations can operate without harming the environment (Figure 3).

Scientists from different countries have researched the relationship between doing business and the environment (Figure 4), where the

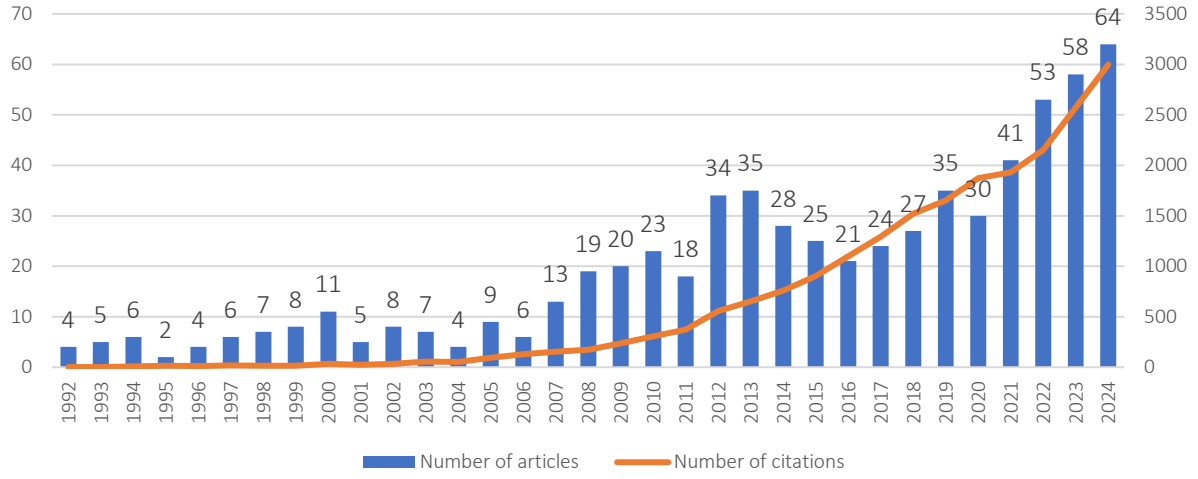

Figure 2. Dynamics of publications and citations during 1992–2024

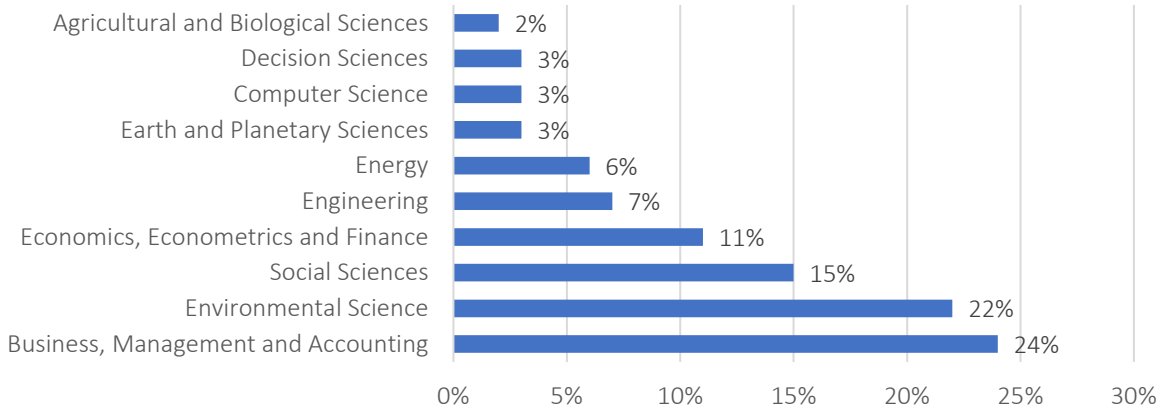

Figure 3. Subject structure of scientific publications in the Scopus database from 1992 to 2024

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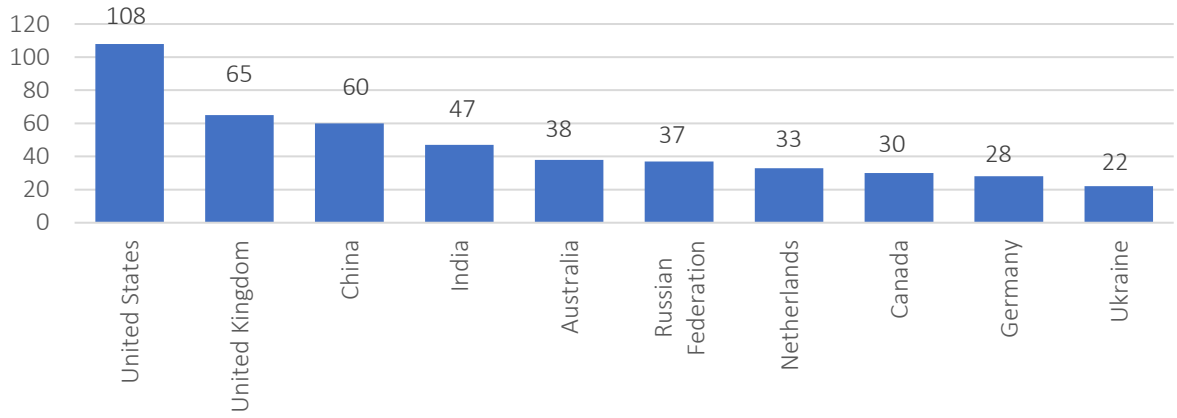

Figure 4. Top 10 countries in terms of the number of publications in the field of greening business

world's large production forces and available resources for doing business are concentrated. Among the countries with the most significant number of studies, the United States is recorded with 108 publications, followed by the United Kingdom with 65 publications, China with 60, India with 47, Australia with 38, Russia with 37, the Netherlands with 33, Canada with 30, Germany with 28, and Ukraine with 22 scientific papers. This trend shows a direct link between business scaling and the environment. In addition, this trend indicates that the environmental situation in these countries is deteriorating and that the scientific community provides facts and evidence of this and offers promising solutions and innovative developments. This trend also indicates that scientists from the United States, Great Britain, and China have conducted more scientific research that can form the basis for future cooperation in solving environmental problems.

An analysis of the data presented in Table 1 on the authors with the most significant number of publications on the greening business shows that J. Sarkis is the leader in the Hirsch index, which is 118. His 2008 report has 494 citations (Zhu et al., 2008). The high value of this index and the most significant number of publications (537), eight of them on the topic under study, indicate that his work is often cited. Govindan and Jabbour also have a high level of the Hirsch index, and the second author's scientific paper from 2017 has the second highest number of citations (Luthra et al., 2017). The analysis of these data reveals the authors' different approaches to the issues of greening business. It highlights the importance of citation indicators, such as the Hirsch index, for assessing the scientific influence of individual researchers. Thus, the high level of publication activity and the high citation of their research indicates that the problems of doing business and its environmental consequences are relevant and popular among the

Table 1. Top 10 leading authors on greening business

Authors	Affiliation	h-Index	Number of Documents	
			Total	Related to greening business
Sarkis, J.	Worcester Polytechnic Institute, Worcester, the United States	118	537	8
Rao, P.	Indian Institute of Management Calcutta, Kolkata, India	11	15	4
Backer, L.	Copenhagen Business School, Frederiksberg, Denmark	5	5	3
Boiral, O.	Université Laval, Quebec, Canada	52	131	3
Cortez, M. A. A.	Ritsumeikan Asia Pacific University, Beppu, Japan	4	7	3
Forbes, L. C.	Western Connecticut State University, Danbury, the United States	8	18	3
Govindan, K.	The University of Adelaide, Adelaide, Australia	113	439	3
Jabbour, C.J.C.	NEOMA Business School, Mont-Saint-Aignan, France	78	314	3
Jermier, J. M.	University of South Florida, Tampa, the United States	14	33	3
Madsen, H.	Handelshøjskolen, Aarhus Universitet, Aarhus, Denmark	11	21	3

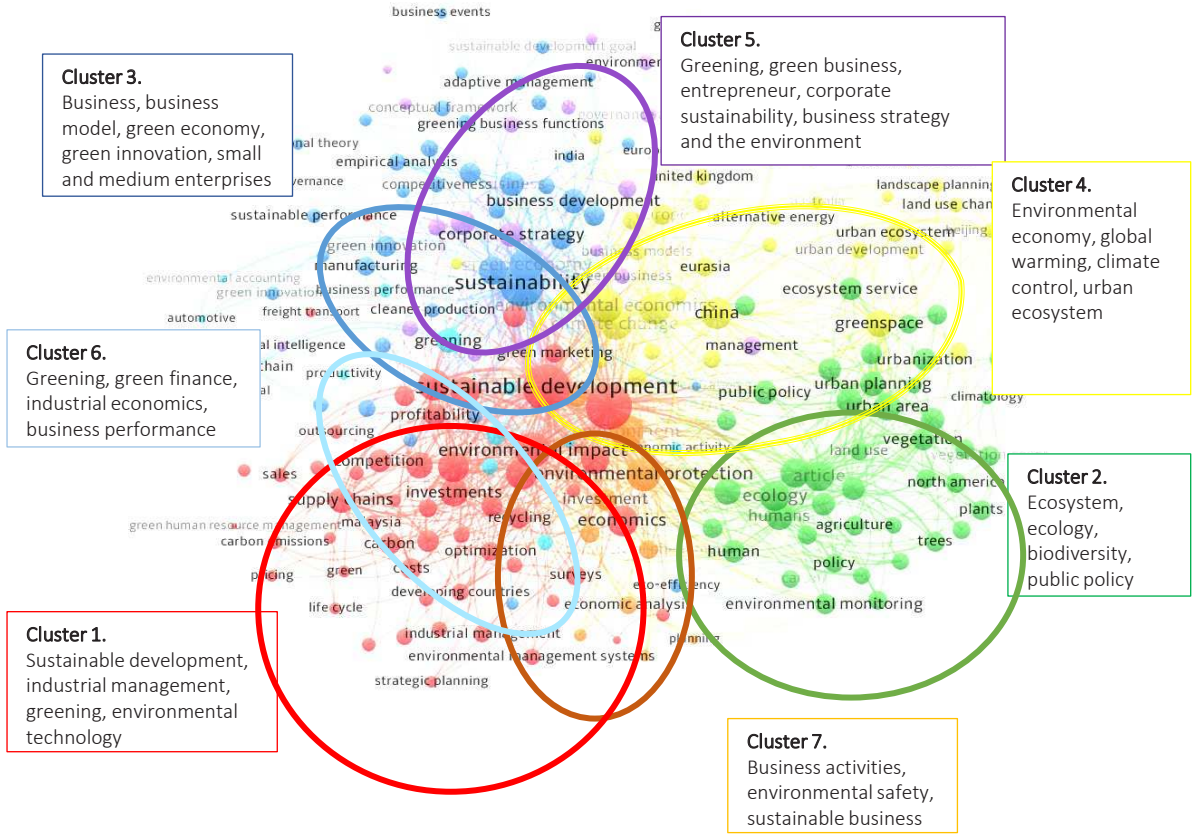

Figure 5. Network of co-occurrence of keywords in publications on greening business

scientific community. Different approaches to the problem emphasize the versatility of the topic and the need for further research.

An important element of bibliometric analysis is analyzing the proximity and relationship between keywords in a selected set of publications; in this case, 3,357 were identified in 660 publications (Figure 5). Based on the data obtained, seven main areas were selected and characterized.

From the point of view of the analysis, the most numerous clusters are the areas highlighted in red (cluster 1). The red cluster highlights keywords such as sustainable development, industrial management, greening, and environmental technology. The research containing these keywords shows that companies implementing environmental technologies strive to minimize their negative impact on the environment and increase their competitiveness through resource conservation and innovation. In addition, this cluster reflects the importance of strategic management in achieving a balance between economic efficiency and environmental responsibility. Cluster 2 (green) covers the following keywords: ecosystem, ecology, biodiversity, and public policy. Research in this cluster highlights the importance of government regulation and policy regarding environmental protection for businesses. It considers the mechanisms of legislative control of business entities through the introduction of environmental standards, tax incentives, and vacations. Cluster 3 (blue) is dedicated to research that contains "business, business model, green economy, green innovation, small and medium enterprises" keywords. Research within this cluster highlights the role of small and medium-sized enterprises (SMEs); unlike large corporations, SMEs have greater flexibility in implementing environmentally friendly technologies and new management solutions that contribute to reducing their carbon footprint and resource management. In addition, the keywords emphasize the gradual formation of a "green" economy, dominated by the development of cyclical business models, energy efficiency, and the use of renewable energy sources, which reduces environmental risks. Cluster 4 (yellow) is dedicated to "environmental economy, global warming, climate control, urban ecosystem." This cluster reveals the relation-

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ship between doing business and the environment, which describes and evaluates the impact of doing business on global warming and climate change. The environmental aspects of urban development are also considered, including the negative impact of urban infrastructure on climatic conditions, and the importance of waste management, energy efficiency improvements, and the development of green areas is also emphasized. Cluster 5 (purple) is dedicated to "greening, green business, entrepreneur, corporate sustainability, business strategy, and the environment," which describes the importance of greening a business and its strategies for influencing the environment. Implementing environmentally oriented business strategies helps reduce costs, increase operational efficiency, improve reputation, and attract investments focused on sustainable development, ultimately leading to greening. Cluster 6 (light blue) is dedicated to topics such as "greening, green finance, industrial economics, and business performance." These keywords reflect the importance of using green finance and sustainable investment tools to support the greening of industry and increase business efficiency. Green finance, including environmental bonds, sustainable investment, and green technology support programs, is key in transitioning to a low-carbon economy. This research trend is popular and has excellent prospects for creating sustainable development. Cluster 7 (orange) is dedicated to the following topics: "business activities, environmental safety, sustainable business." Research in this cluster focuses on the fact that entrepreneurial activity must consider environmental aspects to achieve sustainable development and ensure the safety of the planet. Thus, integrating environmental safety principles into business activity becomes an important condition for sustainable economic growth and social responsibility of business. During the cluster analysis, seven priority scientific areas were identified. These areas aim to improve the environment's state and economic development and reduce risks from industrial business activities.

As part of the analytical work, five main periods were identified, illustrating the evolutionary aspect of the greening business and their multidimensional interrelationships with key terms in the studied layer of interrelationships. Each time lag covers two years (Figure 6). From 2010 to 2012, the first period was devoted to keywords such as environmental economics, environmental management, environmental protection, and sustain-

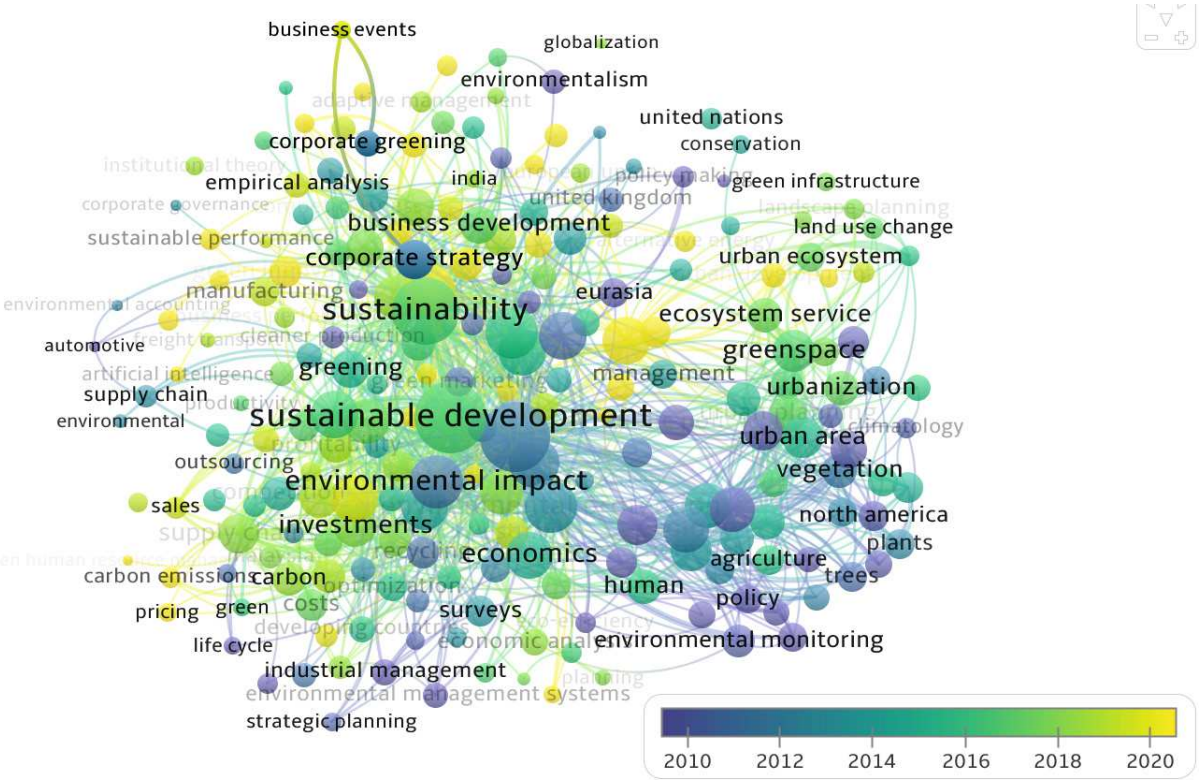

Figure 6. Analysis of the interdependence within the keywords used – An evolutionary aspect

able development. The following area defines the period from 2012 to 2014. The dominant keywords are sustainable development, business activity, and environmental planning. The third area covers the years 2014–2016. The main keywords for the analyzed period are green spaces, government policy, landscaping, and environmental technologies. The period from 2016 to 2018 is characterized by the following keywords: ecosystem, eco-friendly business, industrial practice, and closed-loop economics. The fifth area covers 2018 to 2020 and focuses on business development, greening business functions, commerce, and investments. The listed terms reflect modern views on the greening of business. The keywords show how, in the early stages of the study, they highlighted the impact of business on ecology and the environment. They covered the sustainable management of corporations, which led to the greening of business. In addition, in subsequent periods, the keywords show that introducing environmentally friendly technologies and exceptional innovations can protect the environment from business interference. This study is a valuable source of information in multifaceted analysis, which determines the impact and relationship of business with the environment. An analysis of the evolution of keywords on the chosen topic showed that the topic has evolved from general sustainable development to more specialized aspects such as public policy, environmental technologies, and the green economy. As research has progressed, scientific works shifted from the impact of business on the environment to the introduction of environmentally friendly technologies and innovations that help minimize negative impacts. Thus, the time analysis shows that greening a business is a dynamic process reflecting management and regulatory strategy changes in response to environmental challenges.

CONCLUSION

This study aimed to systematize the world's scientific knowledge on the greening of business as an element of environmentally sustainable development from 1992 to 2024. According to the data obtained, the number of studies on this topic and citations is growing exponentially, with the most significant increase occurring between 2019 and 2024. An increase in the number of publications may lead to new qualitative changes in methodology and practical approaches to quality management. Developed countries like the United States, Great Britain, and other developing countries like China are leaders in doing business and greening it. As noted in the analysis, there are developed enterprises in these countries that increase their competitiveness by introducing "green" elements into their activities. It was also revealed that several authors, like Sarkis, J. and Govindan, K. have publications with a high citation rate and a high Hirsch index, which indicates the topic's significant scientific significance and the variety of research approaches that require further study. In addition, representatives of fields such as economics, environment, sociology, and management are more interested in the problems of doing business and their impact on the environment. Also, the visualization results using the software show the concentration of seven clusters that characterize the planet's sustainable development, the importance of "green" business, the importance of "green" finance, business activity, and reducing the burden on the environment. Thus, based on the study's results, the importance of greening business in maintaining harmony on earth is observed. Further scientific research can focus on how new "green" technologies affect doing business and consider the relationship between digitalization and running a "green" business.

AUTHOR CONTRIBUTIONS

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Formal analysis: Dana Kangalakova, Zaira Satpayeva, Makpal Nurkenova.
Funding acquisition: Zaira Satpayeva.
Investigation: Dana Kangalakova, Zaira Satpayeva.

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Methodology: Dana Kangalakova, Makpal Nurkenova.
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Software: Dana Kangalakova, Makpal Nurkenova.
Supervision: Dana Kangalakova, Zaira Satpayeva.
Validation: Dana Kangalakova, Makpal Nurkenova, Gulnara Nyussupova.
Visualization: Dana Kangalakova, Makpal Nurkenova, Gulnara Nyussupova.
Writing – original draft: Dana Kangalakova, Zaira Satpayeva, Makpal Nurkenova, Gulnara Nyussupova.
Writing – review & editing: Dana Kangalakova, Zaira Satpayeva, Makpal Nurkenova, Gulnara Nyussupova.

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