Entrepreneurship and Green Economic Development: A Bibliometric Investigation

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Abstract

Climate change and the depletion of natural resources are driving the search for mechanisms to transition to a sustainable economy, where entrepreneurship plays a key role in driving environmental innovation. Research in this area remains fragmented, making it difficult to identify policy and education priorities. The aim of this study is to conduct a bibliometric analysis of the scientific space of entrepreneurship and green economic development, identifying thematic priorities, publication dynamics, leading scientists and institutions, and the trajectories of evolution in research approaches. The study provides a systematic understanding of the current state of scientific developments, identifies conceptual gaps, and determines promising areas for further research. The methodological basis of the study is the application of bibliometric methods to a sample of 4,190 publications indexed in Scopus for the period from 1993 to 2025. The sample was formed in accordance with the PRISMA protocol. The analysis was performed using VOSviewer software to study the co-occurrence of terms, citations, and co-authorship. From more than 14,000 keywords, 1,000 terms with the highest level of connectivity, occurring at least five times, were selected. This made it possible to identify key conceptual nodes and their interrelationships. Seven thematic clusters and the evolution of priorities, from macroeconomic issues in the 1990s to the 2000s, to specific implementation mechanisms in the 2010s to the 2020s, have been identified. These clusters include entrepreneurial intentions, the circular economy, and sustainable business models. A 10-dimensional model was proposed that integrates institutional, technological, financial, educational, and socio-behavioural dimensions and aligns microeconomic activity with the macro goals of sustainable development. The study contributes to green entrepreneurship theory by linking firm-level entrepreneurial activity with macro-level sustainability objectives. In practical terms, the work provides scientifically sound tools for higher education institutions in developing interdisciplinary programmes, for government agencies in setting priorities for supporting green business, for entrepreneurs in identifying niches in the circular economy and sustainable models, and for investors in assessing the success factors of venture projects, thereby accelerating the transition to a low-carbon economy while maintaining economic efficiency.

Key words

green entrepreneurship, sustainable development, green economic development, bibliometric analysis, environmental innovation, circular economy, entrepreneurial intentions.

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Introduction

In contemporary scientific discourse, the issue of interaction between entrepreneurship and green economic development is becoming increasingly complex, as the combination of environmental priorities, technological innovations, and market transformations forms a multidimensional and inconsistent research space. Despite the general desire for sustainable development, there are different, sometimes opposing, positions in scientific literature on how exactly entrepreneurship should contribute to green transformations and which mechanisms ensure the greatest effectiveness.

On the one hand, a number of authors argue that the driving force behind green development is macroeconomic and institutional factors that determine the incentives, constraints, and vectors of national environmental policy. Tarasova (2018) emphasises that the adaptability of economic systems in crisis conditions depends primarily on strategic instruments of state regulation that shape new models of enterprise development. Tkachenko et al. (2019) emphasise the strategic role of state forecasting instruments, which set the trajectory for energy conservation in the construction industry by defining the framework for the implementation of sustainable practices.

On the other hand, representatives of the microeconomic and behavioural paradigm believe that key changes occur at the level of the innovative potential of individual enterprises and the willingness of consumers to support environmentally oriented business models. Tambovceva and Titko (2020) demonstrate that consumer participation in the sharing economy model is shaped by individual values and trust levels, rather than institutional conditions alone. Verina et al. (2021) show that digital transformation in education creates the preconditions for a new generation of entrepreneurs capable of integrating sustainability principles and technological innovations.

Some researchers support the position that entrepreneurship can ensure a rapid breakthrough in the implementation of environmental innovations. Grinevich et al. (2019) outline the potential of green entrepreneurship in the sharing economy, while Dzwigol et al. (2021) consider green logistics to be a tool for optimising resources and minimising the environmental footprint. At the same time, Miskiewicz (2021) points out that the implementation of green business models remains challenging due to technological, regulatory, and financial barriers, especially in sectors where the environmental impact is difficult to measure or commercialise.

Thus, contemporary literature reveals a significant fragmentation of views, manifested in different interpretations of the key factors of green development. Some researchers emphasise the dominance of institutional drivers, while others give preference to technological or behavioural factors. The role of entrepreneurship remains equally controversial, with some studies positioning it as the main catalyst for environmental transformation (Grinevich et al., 2019; Dzwigol et al., 2021), while others see it as a phenomenon that is largely dependent on government policy and the regulatory environment (Tarasova, 2018; Tkachenko et al., 2019). Opinions also differ on digital tools, which some authors (Veckalne et al., 2023; Verina et al., 2021) consider a powerful enhancer of innovation, while others (Miskiewicz, 2021; Kozlov, 2021) see them as a source of new socio-economic inequalities. Additional contradictions arise in the interpretation of the interaction between business and consumers in the process of green transformation: some researchers (Olasiuk & Bhardwaj, 2019; Chygryn et al., 2022) focus on market demand, while others (Tambovceva & Titko, 2020; Santoso, 2024) focus on cultural and social mechanisms of influence.

The existence of these opposing approaches indicates a theoretical gap, as scientific discourse still lacks a comprehensive, coordinated vision of the research area that would integrate macroeconomic, microeconomic, institutional, technological, and behavioural dimensions of entrepreneurship in the context of green economic development. Previous studies (Chygryn & Miskiewicz, 2022; Allen & Malin, 2008; Silajdžić et al., 2015) offer a fragmented coverage of individual aspects of the issue, but do not form a comprehensive understanding of its structural logic, key conceptual nodes, and interdisciplinary links.

With this in mind, this study aims to conduct a large-scale bibliometric analysis of the scientific discourse at the intersection of entrepreneurship and green economic development. The purpose of

the article is to identify the main thematic clusters and conceptual dominants, trace the interrelations between key categories, identify evolutionary trends in the formation of the research field, and develop an integrated model that combines the economic, institutional, technological, and behavioural aspects of green transformation. The work fills an existing theoretical gap by proposing a new systematisation of scientific approaches and creating a generalised framework for continuing empirical and theoretical research in this field.

The article has a logical structure focused on the step-by-step disclosure of the research. The first section provides an overview of the current literature with an emphasis on key contradictions and theoretical approaches. The second section describes the methodology, including the criteria for selecting publications and the bibliometric tools used. The third section presents the results through thematic clusters, term co-occurrence maps, and evolutionary trends. In the Discussion section, these results are interpreted in the broader context of scientific debate. The conclusions summarise the theoretical and practical contributions of the work and identify directions for future research.

1. Literature review

In contemporary research, increasing attention has been devoted to the interplay between entrepreneurship, innovation, and green economic development, shaping the complex knowledge landscape in this field. One of the earliest attempts to delineate the role of entrepreneurship in an environmental context was the work of Allen and Malin (2008), who examined green entrepreneurship as a practical approach to natural resource management capable of achieving a balanced integration of economic and ecological interests. Subsequent studies have demonstrated that social and behavioural factors significantly influence intentions to develop green entrepreneurship. For example, Alvarez-Risco et al. (2021) analysed the impact of the COVID-19 pandemic on business university students in Ecuador and demonstrated that environmental awareness, innovativeness, and support from the educational environment are key determinants in shaping entrepreneurial orientation.

A separate area of contemporary research focuses on the role of technology, particularly artificial intelligence, in ensuring green economic development. Chang et al. (2023) emphasised that the rational use of natural resources and growth in 'green' total factor productivity can be achieved by introducing digital technologies that create new opportunities for improving management efficiency and sustainable development. Moreover, Chygryn and Miskiewicz (2022), via bibliometric analysis, reported that research in the field of green competitiveness has evolved from the study of individual environmental policy instruments to a comprehensive vision of sustainable development and innovation strategies.

Demirel et al. (2019) emphasised that "green" startups are characterised by distinct management models and economic mechanisms, requiring institutional support for scaling and market entry. In addition, Dzwigol et al. (2021) elucidated the role of green logistics as an organisational-economic mechanism capable of integrating environmental requirements into business processes, thereby contributing to reducing enterprises' carbon footprint. At the micro level, integrating entrepreneurial initiatives with innovative activities is also critical. Specifically, Ebrahimi and Mirbargkar (2017) demonstrated that green innovations, in the context of market turbulence, are crucial factors in the development of SMEs, ensuring their resilience and adaptability.

The understanding of macroeconomic determinants of sustainable development has further expanded. Gherbi et al. (2024) demonstrated that the combination of economic growth, green financing, and the utilisation of renewable energy sources can significantly reduce CO_2 emissions, laying the foundation for environmentally oriented economic transformation. Concurrently, Gibbs and O'Neill (2014) proposed a revaluation of classical approaches to sociotechnical transitions, highlighting that green business in the construction sector can catalyse systemic change and deliver a truly transformative impact. Grinevich et al. (2019) further enrich the perspective on green entrepreneurship, illustrating that it could be successfully integrated into the sharing economy model,

where the multiplicity of institutional logics creates new opportunities for harmonising environmental and economic objectives.

Thus, the landscape of knowledge about entrepreneurship and green economic development is formed at the intersection of several scientific traditions: natural resource management, behavioural economics, innovation research, digital technologies, and macroeconomic policy. The interaction of these areas allows us to gain a deeper understanding of the nature of green entrepreneurship and outline potential trajectories for its development as a tool for achieving economic sustainability.

The formation of the knowledge landscape of entrepreneurship and green economic development has a multidimensional character, covering both microeconomic and macroeconomic levels and integrating approaches to innovative development, environmental policy, and behavioural aspects (Titko et al., 2023b). Researchers pay considerable attention to the relationship between intellectual capital and financial performance with long-term growth. In particular, Lehenchuk et al. (2023) showed that in the ICT sector, intellectual capital is critical in ensuring sustainability and competitiveness, creating preconditions for green economic development.

An important element of the landscape is the role of green markets in supporting entrepreneurial initiatives. Lotfi et al. (2018) reported that the emergence of new 'green' segments creates conditions for developing intellectual companies, which directly contribute to sustainable development. In a broader macroeconomic context, a study by Luukkanen and colleagues using Laos as an example demonstrated that the performance and efficiency indicators of green growth can be assessed through the concept of a 'sustainability window,' which allows for the identification of structural imbalances in green economic policy (Luukkanen et al., 2019).

A significant portion of contemporary research focuses on the orientation of enterprises toward green development and its implications. Makhloufi et al. (2022) demonstrated that an environmental orientation in entrepreneurship positively impacts ecological outcomes, providing adequate political support and aligning with the resource-based view approach. Similarly, Mondal et al. (2023) identified key factors that facilitate green entrepreneurship development within the circular economy framework, highlighting institutional support, technological innovations, and managerial practices as systemic elements.

Particular attention has been given to the role of financial instruments in developing green startups. Mrkajic et al. (2019) demonstrated that venture capital is increasingly oriented toward ecological innovations, transforming green entrepreneurship into an attractive investment domain. Concurrently, Nikolaou et al. (2011), through SWOT analysis, showed that green entrepreneurship holds significant potential but faces barriers such as insufficient financial resources and underdeveloped institutional support.

Theoretically, O'Neill and Gibbs (2016) emphasised the complexity and dynamism of green economy narratives, noting that green entrepreneurship lacks fixed boundaries and continuously evolves in response to social, political, and economic conditions. In turn, Santoso highlighted that consumer behaviour is increasingly driven by social and environmental responsibility, creating additional demand for green products and services (Santoso, 2024).

In contemporary scientific discourse, entrepreneurship and green economic development are increasingly viewed as interconnected phenomena that shape a new sustainable growth paradigm. In countries with transitional economies, green entrepreneurship often presents a challenge requiring adaptation to institutional weaknesses and financial constraints. This is corroborated by the experiences of Bosnia and Herzegovina, which were analysed by Silajdžić et al. (2015), who reported that ecological initiatives necessitate systemic government support to overcome developmental barriers.

Skordoulis et al. (2022) demonstrated that corporate strategy serves as a mediator between green entrepreneurship, innovation, and competitive advantages, particularly in medium and large enterprises. These ideas are reinforced by Soomro et al., who showed that younger generations exhibit a high propensity for green entrepreneurship, perceiving it as a promising pathway to a green

economy (Soomro et al., 2020). In this context, the development of employee competencies is also critical.

In the realm of consumer behaviour, studies by Taborecka et al. (2023) and Vrablikova et al. (2024) reveal that the attitudes of women across different generations in Slovakia, as well as representatives of Generations X and Y, towards purchasing sustainable clothing are shaped by ecological values, social trends, and trust in sustainable brands. This underscores the growing importance of consumer demand as a driver of green business models. Furthermore, Trapp and Kanbach (2021) proposed a typology of green business models in the technology sector, arguing that archetypes of innovative strategies can serve as a foundation for scaling ecological solutions.

In the broader context of energy policy, Xie et al. (2020) emphasised that coordination between renewable energy sources and green economic development should be based on technological progress that reduces transformation costs.

The contemporary knowledge landscape of entrepreneurship and green economic development unfolds across several key dimensions: the integration of sustainable practices into the operations of small and large enterprises, the increasing role of strategy and innovation in shaping competitive advantages, the growing influence of consumer behaviour and the development of employee competencies, and the institutional and energy-related support for green transformations. These dimensions interact to form a comprehensive scientific framework that elucidates the dynamics and potential of green entrepreneurship in a global context.

2. Methodology

This bibliometric study, which focuses on the landscape of knowledge in entrepreneurship and green economic development, is based on a comprehensive methodology. The Scopus database was used to form a statistical database comprising 4369 scientific publications. The PRISMA guidelines were used to select articles (Fig. 1).

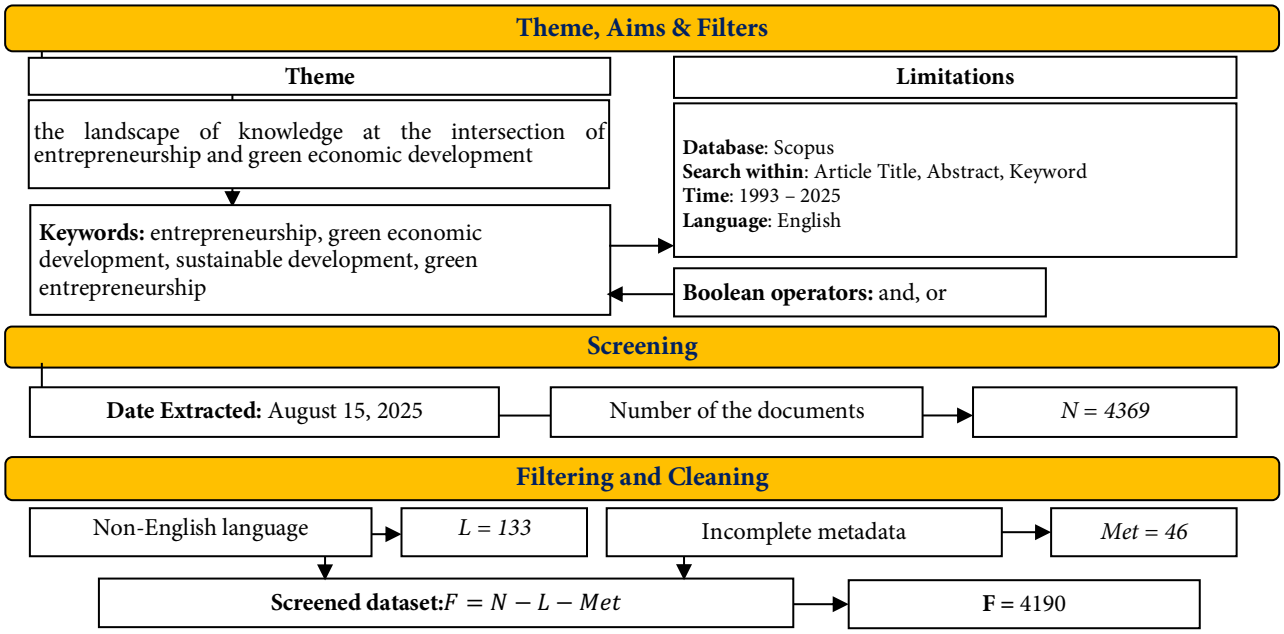

Figure 1. The PRISMA guidelines for meta-analysis of the papers focus on the knowledge landscape of entrepreneurship and green economic development, which are indexed in Scopus.
Source: Developed by the authors.

The search strategy was based on a combination of keywords covering the main aspects of the topic, such as 'entrepreneurship', 'green economic development', 'sustainable development', and 'green entrepreneurship'. This allowed us to obtain a representative sample for further analysis.

To select the articles, the following parameters were used:

- Keywords: entrepreneurship, green economic development, sustainable development, green entrepreneurship.
- Boolean operator: AND, OR.
- Timeframe: 1993-2025.
- Language: English.

In the first step, 4369 articles were identified. After the completeness of the language and metadata was verified, non-English publications (133) and documents with incomplete metadata (46) were excluded. As a result, the final dataset comprised 4,190 articles that were included in the analysis.

VOSviewer software was used to process and visualise the collected data. At the first stage of analysis, a minimum threshold for the appearance of a keyword was set at 5 times, allowing rare terms to be filtered out and focusing on the most significant ones. As a result, out of more than 14,000 initial words, 1,200 relevant terms were included in the analysis. From these, the 1,000 keywords with the strongest connections were selected, which ensured clear visualisation and analysis. This study encompasses an analysis of word co-occurrence to identify thematic clusters, a citation analysis to identify influential works, and a coauthorship analysis to examine collaboration networks. This approach offers a comprehensive and nuanced understanding of the structure and dynamics of scientific knowledge in this field.

3. Research results

Forming a holistic view of the knowledge landscape of entrepreneurship and green economic development requires the integration of various scientific approaches and research results that highlight the interrelationships among the economic, social and environmental components of sustainable development. The analysed sources enable us to identify the key determinants of green entrepreneurship development, among which the institutional environment, innovative practices, entrepreneurial orientations, consumer behaviour, and strategic business approaches are decisive. At the intersection of these factors, a framework model is formed (Table 1), which summarises knowledge about the driving forces, barriers and prospects of green transformations in entrepreneurial activity.

Table 1. Framework Model of the Knowledge Landscape of Entrepreneurship and Green Economic Development.

Fields of knowledge	Characteristics
Resource and environmental foundation	Green entrepreneurship as a mechanism for sustainable natural resource management and reduction of environmental impact; operational carriers – green logistics and environmentally optimised supply chains (Allen & Malin, 2008; Dzwigol et al., 2021).
Behavioural intentions and human capital	The propensity of young people and students towards green entrepreneurship, the role of education and values, the development of 'green' competencies among employees as a condition for the internal institutionalisation of sustainable practices (Alvarez-Risco et al., 2021; Soomro et al., 2020)
Technological and digital driver	AI and technological progress as enhancers of green productivity; digitisation of waste and energy management systems to support the circular economy (Chang et al., 2023; Mondal et al., 2023; Xie et al., 2020)
Business models, strategy and innovation	Archetypes of green technology business models, company strategy as a mediator between entrepreneurship, innovation and competitive advantages; specifics of SMEs in turbulent times (Ebrahimi & Mirbargkar, 2017; Skordoulis et al., 2022; Trapp & Kanbach, 2021)
Finance and investments	The role of venture capital and green financing in scaling up environmental innovations; market opportunities in new green segments (Gherbi et al., 2024; Lotfi et al., 2018; Mrkajic et al., 2019)
Institutions, policy and regional dimension	The "Green Deal," renewable energy policy, support for transitional economies, sustainable tourism, and small businesses as factors in regional development (O'Neill & Gibbs, 2016; Silajdžić et al., 2015).
Green growth macroeconomics	Assessment of green growth performance ("window of sustainability"), coordination of RES and growth through technological shifts, tools for forecasting green competitiveness (Luukkanen et al., 2019; Xie et al., 2020)
Market, Consumer, and Brand	Social and environmental responsibility as a driver of demand; consumer behaviour in the sustainable clothing market; promotion of the 'green brand of the country' as a reputational asset for entrepreneurship (Santoso, 2024; Taborecka et al., 2023; Vrablikova et al., 2024)
Intellectual capital and resilience of an enterprise	The impact of intellectual capital on financial performance and sustainable growth in knowledge-based industries; vulnerability management as the basis for sustainable strategies (Lehenchuk et al., 2023)

Circular integration	Enablers of green entrepreneurship in the circular economy (institutions, technologies, management) and their connection with digitalisation and waste-centric business cases Mondal et al., 2023)

Source: Compiled by the authors

The proposed model is not only the result of systematising existing scientific developments but also a methodological basis for further in-depth analysis of the processes of forming a green economy and enhancing business competitiveness in the face of global challenges.

A bibliometric analysis of scientific publications was conducted to empirically verify and specify the developed framework model of the entrepreneurship and green economic development knowledge landscape.

The results shown in Figure 1, obtained via the VOSviewer software tool, demonstrate the scientific field under study. The term cluster map shows that the concepts of 'sustainable development' and 'sustainability' are at the research center, integrating blocks related to entrepreneurship, innovation, environmental aspects and education. This structure confirms the subject's interdisciplinary nature and allows us to identify the links between entrepreneurial activity and green economic development processes.

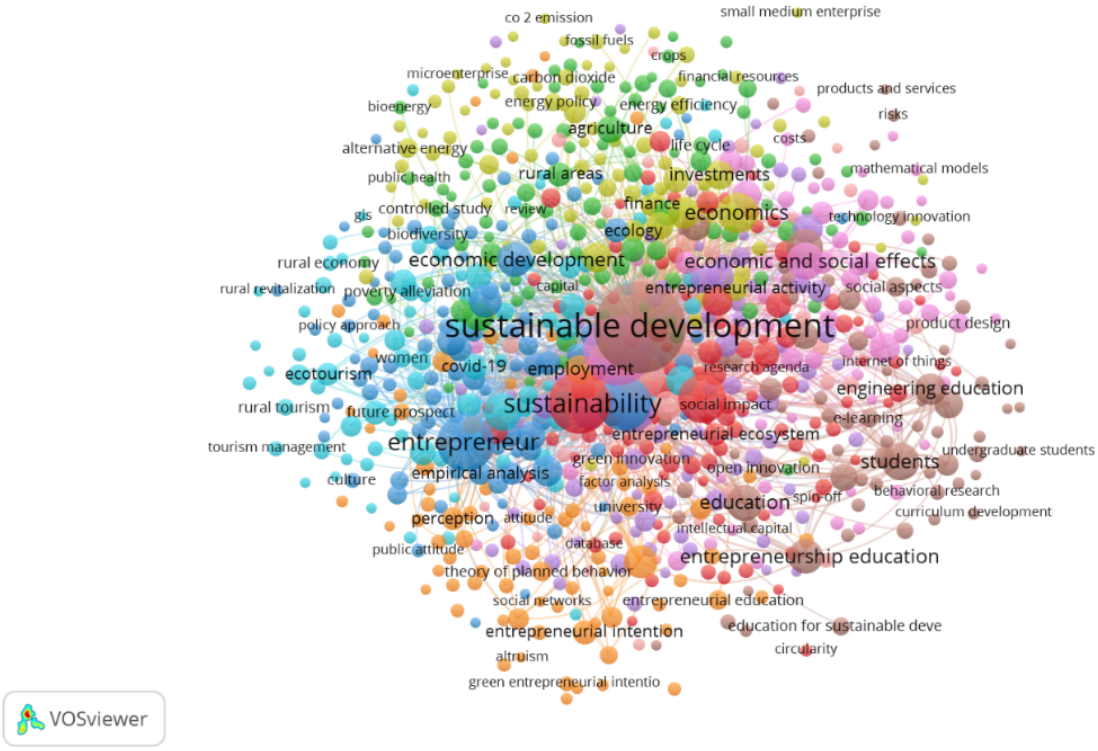

Figure 2. Visualisation of the co-occurrence analysis of investigations focused on entrepreneurship and green economic development.
Source: Developed by the authors.

Several main clusters can be identified on the map, demonstrating the key research areas. Clusters 1 and 2 'Sustainable Development and Economics' (green and purple). These clusters are central and the largest, emphasising their fundamental importance to the entire topic. Keywords: sustainable development, economic development, economics, investments, environmental economics, energy efficiency. These clusters combine the macroeconomic aspects of sustainable development. Research belonging to these clusters focuses on the impact of economic instruments, investments and resource efficiency on achieving sustainable development. This is the core of the green economy, where theory meets practice.

Clusters 3 and 4, 'Entrepreneurship and Education' (red and orange), directly relate to entrepreneurship and its formation. Keywords: entrepreneurship education, students,

entrepreneurial intention, education, curriculum, higher education institutions. These clusters focus on the educational aspect of training green entrepreneurs. The research here analyses how educational programs and institutions can influence students' intentions to start a business focused on sustainable development.

Cluster 5, 'Environmental Innovation and Technology' (blue), demonstrates the link between entrepreneurship and technological solutions–keywords: innovation, entrepreneur, business, and green innovation. The cluster reflects the role of entrepreneurs in creating and implementing innovative technologies to solve environmental problems. This is the micro level of entrepreneurial activity, where the emphasis is on the development and commercialisation of 'green' products and services.

Clusters 6 and 7, 'Social and Behavioural Aspects' (purple and pink), reflect the human factor in the green economy–key words: social effects, behavioural research, human development, perception, and knowledge-based systems. The clusters focus on consumer behaviour, individual perceptions and the social consequences of the transition to a green economy. This shows that economic and technological solutions alone are not enough for the successful implementation of green initiatives; it is also important to consider the human factor.

This clustering is a logical reflection of global macroeconomic trends. In particular, the growing interest in this topic has been driven by factors such as global warming and increasing climate risks, which require changes in economic models. Policies aimed at decarbonisation and the circular economy have been a driving force for investment in green technologies. The COVID-19 pandemic may also have contributed to the shift in focus, as much research has focused on environmentally conscious economic recovery ('green recovery'). Thus, the clusters reflect academic interests and the scientific community's response to key global challenges and economic transformations in recent decades.

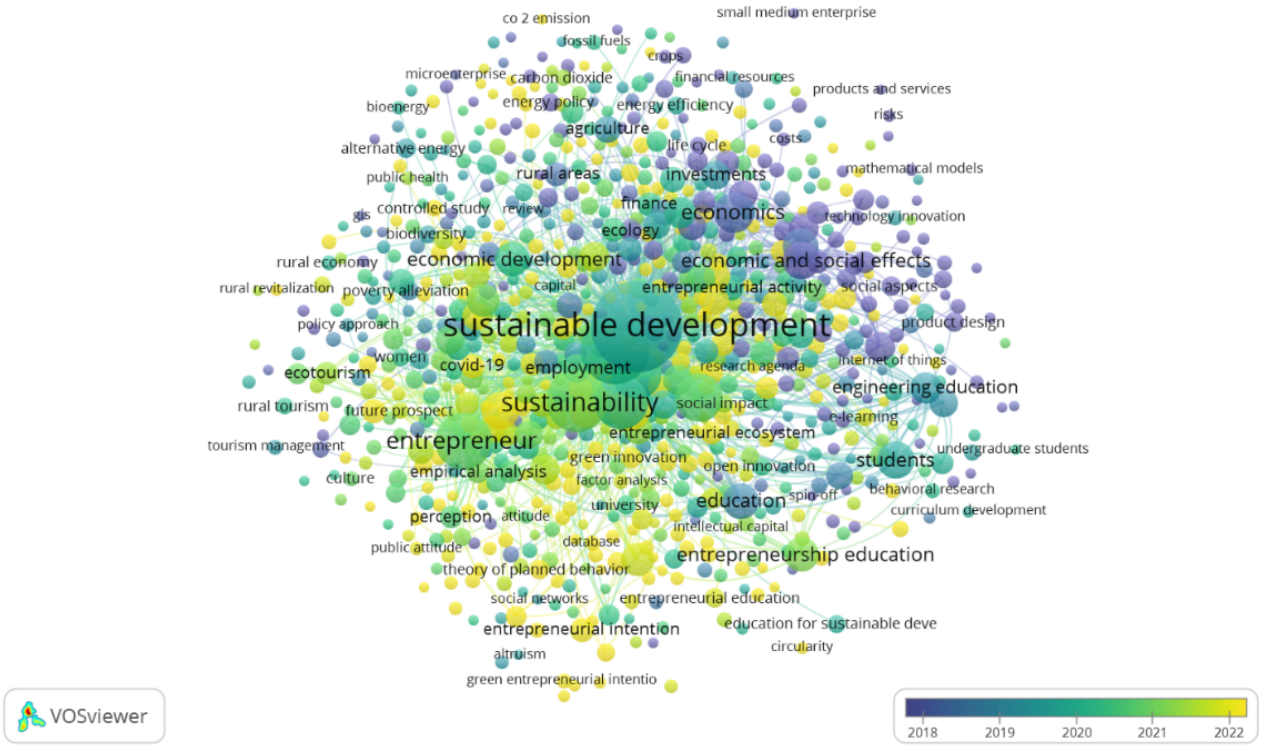

Figure 3. The results of the analysis of the evolution of investigations focused on entrepreneurship and green economic development.
Source: Developed by the authors.

The constructed map visualises the evolution of keywords and allows us to trace how the focus of scientific interest has changed over time for the subject under study.

In the relatively early period (blue/light blue cluster), research focused on general, fundamental concepts such as 'sustainable development,' 'economic development,' 'CO2 emissions,' and 'renewable energy resources.' These basic, macroeconomic studies laid the theoretical foundation for further work.

In the late period (yellow/green cluster) transition, the emphasis shifted to the micro level and practical aspects. Words such as 'entrepreneurship education,' 'entrepreneurial intention,' 'green business,' 'innovation,' and 'circularity' appear and become more significant. This indicates a shift from general discussions about sustainability to specific issues of implementing a green economy through entrepreneurial activity and education.

Key macroeconomic and social factors, including global politics and regulation, have influenced this evolution and clustering. Coordinated actions by governments and international organisations (the Paris Agreement) have increased attention to climate issues. This has stimulated investment in green infrastructure and technologies, which have required scientific justification and the search for new business models.

Technological progress, such as the rapid development of technologies in renewable energy, smart cities and the circular economy, has also created new opportunities for entrepreneurs. This led to the emergence and study of terms related to 'green innovation' and 'product design.'

It is also worth noting social pressure and awareness. The growing environmental awareness of consumers and investors demands greater social responsibility from businesses. Research has begun to focus on behavioural aspects, ecotourism and social effects.

The crisis caused by the COVID-19 pandemic has intensified the debate on 'green recovery'. This has prompted researchers to study how the principles of the green economy can be integrated into crisis recovery strategies.

An analysis of the bibliometric map of the evolution of keywords on the subject under study indicates a consistent and logical development of scientific knowledge. The initial stage, focused on macroeconomic and theoretical aspects of sustainable development, has gradually transformed into a more applied and innovative stage, where entrepreneurial initiative plays a key role. This transition from a general concept to specific implementation mechanisms confirms that the scientific community is actively responding to global challenges and macroeconomic trends. The evolution from terms related to politics and ecology to words describing entrepreneurs' education, intentions and behaviour reflects the realisation that the transition to a green economy is impossible without the active involvement of innovative potential at the micro level and the formation of a new generation of entrepreneurs. Thus, the map is not just visualisation but also empirical evidence of the maturity and dynamism of a research field that is constantly adapting to the demands of the times and changing economic realities.

4. Discussion

The results of the bibliometric analysis demonstrate that the research space combining entrepreneurship and green economic development is becoming increasingly interdisciplinary and conceptually profound. The key clusters identified are consistent with the trends described in contemporary scientific works (Allen & Malin, 2008; Chygryn & Miskiewicz, 2022; Demirel et al., 2019; Grinevich et al., 2019; Mondal et al., 2023; Silajdžić et al., 2015), confirming the validity of the conclusions and their connection to the broader context of sustainable development.

First, the results of the study emphasise the growing role of environmental innovation as a driver of business model transformation. This finding is consistent with the results of Shaukat et al. (2023), who emphasise that eco-innovation, combined with market uncertainty, stimulates the formation of a green marketing orientation and has the potential to improve business performance. Similarly, Wagan et al. (2025) reported that market and management factors significantly influence the

effectiveness of green innovations, confirming the importance of integrating innovative practices into strategic management.

The second important area is green consumer demand and behavioural determinants, which are reflected in our clusters related to social behaviour and brand. Olasiuk and Bhardwaj (2019) demonstrated that consumer decisions regarding green brands depend on awareness and trust, which directly correlate with the increasing frequency of the terms "green brand," "awareness," and "trust." Similar conclusions are presented in Santoso (2024), where the author emphasises the need to consider social and environmental aspects of consumer behaviour as key drivers of the market transition to sustainability. Additionally, the results of Chygryn et al. (2022) show that green brands and energy-efficient consumption are becoming important parts of the communication system, shaping new market logics and advantages.

The third key area is human capital, competencies and social aspects of entrepreneurship, which emphasise a shift in research towards behavioural and educational determinants. Gobniece and Titko (2024) emphasise that digital transformation requires the development of new competencies that support environmentally oriented business models simultaneously. The development of staff competencies is also reinforced by green HR practices, as demonstrated by a study by Surya et al. (2024), which shows that innovations in human resource management contribute to achieving sustainable development goals.

The gender aspect, identified in our analysis as one of the areas of behavioural research, is consistent with the findings of Tovmasyan (2022). In particular, female entrepreneurship in tourism contributes to strengthening the sustainability of regional development, and the gender characteristics of entrepreneurial behaviour have a direct effect on the innovative potential of countries.

The fourth dimension concerns institutional and financial support for green transformations, as confirmed by our conclusions regarding the centrality of institutional and political factors. Research by Khalatur and Dubovych (2022) demonstrates that financial engineering in the field of green finance is crucial to the development of an effective system of support for environmental innovation. Similar results were obtained by Alagpuria (2021), who confirmed the existence of financial gaps in the development of sustainable entrepreneurship, especially among SMEs. Moreover, Gavkalova et al. (2022) demonstrated that the development of renewable energy, even in times of crisis, has a positive effect on the environment and can support green entrepreneurship, provided that there is political stability and investment.

The fifth trend emerging from our analysis is digitalisation, smart technologies and circular models, which have become among the key elements in the evolution of scientific approaches. Veckalne et al. (2023) reported that digital services, such as mobile applications, promote sustainable consumption patterns in urban ecosystems. These findings correlate with a global shift from studying purely environmental aspects to exploring the synergy between digitalisation and circularity. Chygryn and Miskiewicz (2022) also confirmed the evolutionary nature of green competitiveness development, which is reflected in the growing importance of the terms competitiveness, transformation, and innovation in our study.

A comparison of our results with those of Kozlov (2021) and Tarasova (2018) reveals that managing negative externalities, adaptability, and strategic flexibility remain fundamental factors in the sustainability of enterprises. In the context of the circular economy, the problem of managing enterprise vulnerability is particularly important, as transformations require systemic changes in operational and strategic processes.

The results confirm the strengthening of the integrative role of culture and social norms in shaping the green economy. Research by Titko et al. (2023a) demonstrates that a country's cultural development significantly influences its ability to achieve the Sustainable Development Goals and that students' attitudes towards sustainable entrepreneurship are shaped in relation to their level of

education, values, and trust. This is fully consistent with the increasing frequency of the terms awareness, attitude, and intention in our evolutionary map.

Thus, the results of the discussion indicate that green economic development is shaped by the interaction of technological, behavioural, institutional, and financial factors. Our data complement existing research findings and demonstrate that contemporary scientific discourse is moving towards deepening interdisciplinary links, focusing on the integration of eco-innovation, social behaviour, digital technologies and strategic management.

Conclusions

The bibliometric analysis revealed that the scientific space at the intersection of entrepreneurship and green economic development is multidimensional, dynamic, and characterised by steady growth in interest over the past decades. The categories of sustainable development and economic sustainability, which integrate innovative, entrepreneurial, environmental, sociobehavioural and educational aspects, occupy a central place in the structure of this space. Mapping key terms and their connections has made it possible to identify seven main clusters that reflect the main directions of development in the field, among which 'Sustainable Development and Economics' and 'Entrepreneurship and Education' dominate. This confirms that the formation of a green economy takes place simultaneously at the macro level through institutions, politics, finance and energy transformations and at the micro level through the development of innovation, entrepreneurial orientation, the educational environment and behavioural changes.

The ten-dimensional knowledge model proposed by the authors systematises key conceptual directions and demonstrates the consistency between institutional, technological, financial, educational and behavioural determinants of green transformations. Visualisation of the evolution of key terms has revealed a shift in focus from general macroeconomic issues of sustainability to issues of practical implementation, particularly entrepreneurial intentions, digitalisation, innovative business models and circular practices. This confirms the gradual maturation of the field under study and the strengthening of interdisciplinary links.

The results of this study have significant theoretical and practical value. Theoretically, this work clarifies the structure of scientific approaches in the field and offers a comprehensive view of the relationships among economic, technological, and sociobehavioural factors in the development of green entrepreneurship. The practical significance lies in the possibility of using the results to improve educational programmes, identify areas of support for green business, search for innovative niches in the circular economy, and strengthen the role of entrepreneurship in achieving sustainable development goals.

From a policy perspective, the research results emphasise the importance of creating institutional conditions that stimulate the development of innovative and environmentally oriented entrepreneurial practices. The identified clusters demonstrate that effective public policy must cover environmental regulation, education development, innovation support, the creation of financial mechanisms, and the promotion of circular models simultaneously. The identified strengthening of the role of educational and behavioural aspects also indicates the need to support programmes for the development of entrepreneurial competencies and environmental awareness.

This study has certain limitations related to the specifics of the bibliometric method. The use of only the Scopus database and a minimum threshold for the appearance of keywords limits the inclusion of less represented but potentially important studies. Bibliometric tools allow us to identify the structure and dynamics of the scientific field, but they do not allow us to assess the causal relationships between individual factors of green development or the depth of conceptual discussions.

Further research may focus on empirical verification of the proposed model, in-depth analysis of individual clusters, study of regional characteristics of green ecosystem formation, and investigation of how digitalisation and behavioural changes are transforming traditional business models. The expanded use of mixed and qualitative methods will allow for a deeper understanding of the

mechanisms of interaction between entrepreneurship and green development, strengthening the theoretical and practical basis for further research.

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