

Exploring the Knowledge Map of Green Entrepreneurship through Bibliometric and Co-Word Mapping Analysis Word Mapping

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ABSTRACT

Green entrepreneurship has gained prominence as a transformative approach to addressing environmental challenges while promoting economic growth. Despite its growing scholarly appeal, the field remains fragmented with diverse interpretations and thematic overlaps. This study employs a bibliometric and co-word mapping analysis to explore the intellectual structure, thematic evolution, and emerging trends in green entrepreneurship literature. Drawing data from the Scopus database and analyzing it using VOSviewer, we identified key authors, collaboration networks, influential countries, and conceptual clusters shaping the field. Central themes include sustainable development, innovation, green economy, and entrepreneurship education. Temporal mapping reveals a recent shift toward educational and capability-based approaches, particularly post-2021. The study highlights the need for deeper theoretical integration, broader regional representation, and enhanced collaboration across disciplines and geographies. These findings provide a comprehensive knowledge map to guide future research, policy formulation, and entrepreneurial practices aligned with global sustainability goals.

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1. INTRODUCTION

Green entrepreneurship has emerged as a critical area of study in response to the growing concerns over environmental degradation, climate change, and sustainable development. This field represents a convergence between environmental responsibility and innovative entrepreneurial practices aimed at creating ecological and economic value [1]. Unlike traditional entrepreneurship, green entrepreneurship places sustainability at the core of its business

models, ensuring that the exploitation of resources, direction of investments, and technological development contribute to environmental preservation. In recent years, this concept has attracted substantial academic attention, particularly as global economies seek resilient and low-carbon pathways for growth [2].

As nations strive to align with international agreements such as the Paris Agreement and the UN's Sustainable Development Goals (SDGs), the role of green entrepreneurs becomes increasingly vital.

These actors operate not only within market dynamics but also within ecological and regulatory frameworks that guide their decision-making [3]. Consequently, understanding the development and trajectory of green entrepreneurship literature is important for scholars, policymakers, and practitioners alike. It enables a clearer understanding of how academic discourse supports practical transformations toward sustainability in various sectors and regions.

Despite its growing relevance, the conceptual boundaries and thematic structures of green entrepreneurship remain fragmented. Several related subtopics—such as eco-innovation, sustainable startups, green business models, and environmental policy—intersect with green entrepreneurship, often creating terminological and conceptual overlaps [4]. These overlaps make it challenging to construct a unified knowledge base, thereby impeding theoretical development and empirical validation. A systematic mapping of the intellectual landscape is necessary to identify central research themes, emerging trends, and influential contributions in the field.

Bibliometric analysis offers a robust methodological framework to explore the evolution and structure of scientific disciplines. By applying bibliometric tools, researchers can assess publication trends, authorship patterns, institutional affiliations, and citation networks. More importantly, co-word analysis provides insights into the cognitive structure of a field by examining the co-occurrence of keywords within academic publications [5]. When applied to green entrepreneurship, these methods help construct a comprehensive knowledge map, revealing key concepts, topic clusters, and research gaps that require further exploration.

Although research on green entrepreneurship is growing, there is limited clarity on its intellectual structure, thematic evolution, and the interrelationship between emerging concepts. The absence of a comprehensive knowledge map makes it difficult for researchers to understand the field's developmental trajectory, identify

seminal works, and explore interdisciplinary linkages. This gap hampers both theoretical advancements and practical implementation in policy and entrepreneurship education. This study aims to explore the knowledge structure of green entrepreneurship by conducting a comprehensive bibliometric and co-word mapping analysis of scholarly publications.

2. METHODS

This study adopts a bibliometric and co-word mapping analysis approach to examine the intellectual landscape of green entrepreneurship. Bibliometric analysis is a quantitative method used to assess the academic literature by evaluating patterns such as publication trends, citation counts, and co-authorship networks [6]. To complement this, co-word analysis was applied to uncover the conceptual structure and thematic evolution of the field by analyzing the co-occurrence of keywords in titles, abstracts, and author keywords.

2.1 Data Source and Retrieval

The dataset for this study was extracted from the Scopus database, selected for its comprehensive coverage of peer-reviewed scientific literature across disciplines. The search query was designed to capture relevant documents related to green entrepreneurship, using the following string applied to article titles, abstracts, and keywords: "green entrepreneur*" OR "ecopreneur*" OR "sustainable entrepreneur*". The search was limited to journal articles, conference papers, and reviews published in English between 2000 and 2024. All duplicate entries and non-relevant records (e.g., papers focused solely on environmental sciences without entrepreneurial focus) were manually screened and removed, resulting in a final dataset of 1000 documents (actual count to be inserted post-retrieval).

2.2 Data Processing and Analysis Tool

All bibliometric data were exported in CSV format compatible with VOSviewer. VOSviewer was utilized for the following

analytical tasks: (1) co-authorship analysis, (2) co-citation analysis, (3) keyword co-occurrence analysis, dan (4) temporal evolution mapping. VOSviewer constructs visual maps where items (e.g., keywords or authors) are represented as nodes. The distance between nodes indicates the relatedness based on co-occurrence frequency, and clusters are automatically formed using a modularity-based clustering technique to identify thematic groupings.

2.3 Co-Word Analysis Procedure

For the co-word analysis, the author keywords (DE field) were primarily used due to their consistency and researcher-provided relevance. A threshold for minimum keyword occurrences (e.g., 5 times) was applied to ensure analytical clarity. Synonyms, spelling variants, and plural/singular forms were normalized to enhance data consistency (e.g., “green business” and “green businesses” were merged).

The co-word map generated displays clusters of keywords that frequently appear together, highlighting dominant themes (e.g., sustainability, innovation, circular economy) and emerging subtopics. The strength of links between keywords indicates the intensity of conceptual connections, and cluster colors represent distinct thematic areas.

3. RESULTS AND DISCUSSION

3.1 Co-Authorship Analysis

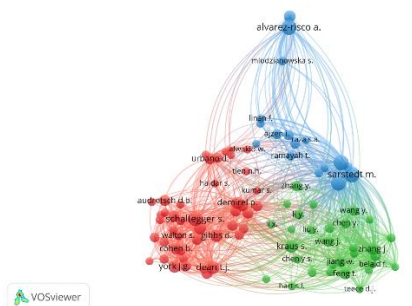


Figure 1. Author Visualization

Source: Data Analysis

The co-authorship network visualization generated using VOSviewer reveals three prominent clusters of researchers contributing to the field of green entrepreneurship. The red cluster primarily

includes foundational scholars such as Schaltegger S., Gibbs D., and York J.G., who are known for advancing sustainability-oriented entrepreneurship frameworks. The green cluster highlights a group of authors such as Kraus S., Zhang Y., and Chen Y., who appear to focus on the empirical and policy-related dimensions of green business, often from a managerial or innovation-driven perspective. Meanwhile, the blue cluster, dominated by Sarstedt M. and Alvarez-Risco A., indicates a network of researchers possibly working on methodological contributions or interdisciplinary approaches. The tight interconnections within each cluster and selective cross-cluster links suggest a high degree of collaboration within specific schools of thought, with limited but growing interdisciplinary integration. The size of the nodes reflects the publication volume or centrality of the authors, showing Sarstedt M. and Schaltegger S. as particularly influential figures in the knowledge structure of green entrepreneurship.

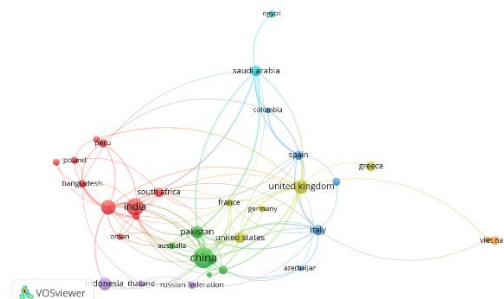


Figure 2. Country Visualization

Source: Data Analysis

The country co-authorship network visualization reveals distinct regional clusters of international collaboration in the field of green entrepreneurship. India emerges as a central hub in the red cluster, actively collaborating with countries such as Bangladesh, South Africa, Oman, and Peru, indicating strong South-South cooperation. China, positioned in the green cluster, also plays a key role with robust connections to Pakistan, Australia, and the United States, highlighting its influence in both regional and global research networks. The United Kingdom, located centrally in the map and part of the blue cluster, acts as a bridge

The co-word network visualization presents a thematic structure of the green entrepreneurship literature based on keyword co-occurrence. At the center of the map, "green entrepreneurship" and "sustainable development" appear as the most dominant and interconnected terms, indicating their foundational role in the field. These core concepts link to various subthemes, reflecting the multidimensional nature of research in this domain. Their central positioning suggests that most scholarly work builds upon or aligns with these two pillars, serving as convergence points for diverse research strands.

The green cluster, surrounding keywords like *environmental sustainability*, *environmental protection*, and *competition*, indicates a strong ecological and environmental management focus. This suggests that a significant portion of green entrepreneurship literature explores the alignment between entrepreneurial ventures and ecological conservation goals. This cluster also reflects the influence of global environmental discourse, where businesses are not only seen as economic agents but also as environmental stewards contributing to long-term planetary health. The red cluster centers around themes such as *innovation*, *green economy*, *green innovation*, and *policy making*. This cluster likely represents the economic and innovation-oriented discourse within green entrepreneurship. The integration of *environmental economics* and *green entrepreneurial orientation* into this group signals a policy and institutional dimension—highlighting how innovation policies, environmental regulations, and entrepreneurship education contribute to shaping green business ecosystems. Moreover, terms like *climate change* reinforce the urgency of innovation as a response to ecological crises. Meanwhile, the blue cluster, which includes keywords like *ecopreneurship*, *sustainable entrepreneurship*, and *entrepreneurship education*, underscores a conceptual and educational perspective. It shows the theoretical evolution and differentiation of green entrepreneurship

from overlapping constructs. The presence of *entrepreneurship education* suggests the growing role of academic institutions in nurturing environmentally-conscious entrepreneurs.

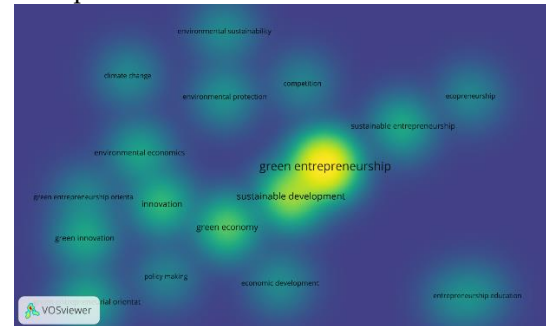


Figure 4. Density Visualization

Source: Data Analysis

The heatmap visualization highlights the density of keyword co-occurrences in the literature on green entrepreneurship. The most intense area—marked in bright yellow—centers around "green entrepreneurship" and "sustainable development", indicating these two keywords are the most frequently occurring and strongly connected concepts in the dataset. Their prominence reflects their centrality to the discourse and suggests that most studies in this field either revolve around or integrate these two foundational themes. Other moderately dense areas (shown in green) include terms such as "green economy", "innovation", and "environmental economics", suggesting these topics are also frequently studied, but with slightly less centrality. The heatmap also shows peripheral but relevant themes like "ecopreneurship", "entrepreneurship education", "climate change", and "policy making", which are less dense (indicated by cooler tones like blue and green). While these terms appear less frequently, they still play meaningful roles within the broader knowledge structure of green entrepreneurship. Their peripheral positioning may indicate emerging or niche research areas that could gain more attention in the future.

3.4 Temporal Evolution Mapping

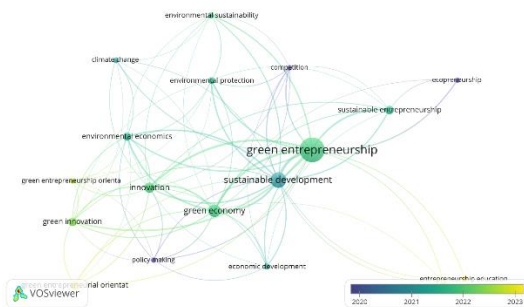


Figure 5. Temporal Visualization

Source: Data Analysis

The overlay visualization illustrates the temporal evolution of green entrepreneurship research keywords from 2020 to 2023. Central themes like "green entrepreneurship", "sustainable development", and "green economy" appear in darker green shades, indicating they have been consistently studied over the years. In contrast, newer and more recent topics—shown in yellow—such as "entrepreneurship education", "green innovation", and "green entrepreneurial orientation" have gained prominence in the latest research, particularly post-2022. This temporal shift suggests a growing interest in educational frameworks and innovation strategies supporting green entrepreneurship. The evolving color gradient provides insights into how the field is gradually expanding beyond core sustainability themes toward more practice-oriented and policy-relevant areas.

DISCUSSION

Intellectual and Author Collaboration Structure

The co-authorship network analysis identifies three major clusters of researchers, suggesting the formation of intellectual communities around particular theoretical or methodological orientations. For example, scholars such as Schaltegger S., Gibbs D., and York J.G. are highly central in the red cluster, representing foundational work on sustainability transitions, entrepreneurial ecosystems, and policy implications for green enterprise. Meanwhile, Sarstedt M. and Alvarez-Risco A., leading the blue cluster, represent a network more inclined toward methodological rigor, including structural

equation modeling and cross-disciplinary analytics. The green cluster, featuring authors like Kraus S., Zhang Y., and Chen Y., appears to reflect applied and regional studies—particularly from Asia—focusing on innovation, green strategy, and policy. The high-density links within clusters highlight strong internal collaborations, while the thinner cross-cluster connections suggest emerging interdisciplinary efforts. The prominence of authors from different continents indicates that green entrepreneurship is not just a Western-driven agenda but a truly global field with localized adaptations. However, a noticeable gap remains in the form of limited South-South collaboration, and more efforts are needed to build inclusive, transnational research partnerships.

Geographical Collaboration and Distribution

The country co-authorship analysis reveals that India, China, and the United Kingdom act as central nodes in international collaboration networks. India forms a vibrant red cluster, reflecting regional cooperation with Bangladesh, Oman, and South Africa, indicative of strong engagements in the Global South. China, meanwhile, forms its own green cluster but maintains strong bilateral links with the United States, Pakistan, and Australia, showing its position as a research powerhouse in both North-South and East-West networks. The United Kingdom plays a bridging role, fostering connections across Europe, the Middle East, and Asia. The visualization also shows more peripheral participation from countries like Vietnam, Indonesia, and Thailand, suggesting rising interest but still limited integration into the core scholarly networks. These findings echo earlier studies which emphasize the uneven global distribution of sustainability research and the importance of facilitating greater inclusion for underrepresented regions. International funding mechanisms, open-access collaboration platforms, and joint PhD programs could serve as enablers of broader global engagement in green entrepreneurship research.

Thematic Structure and Conceptual Focus

The keyword co-occurrence network highlights **three dominant thematic domains** in green entrepreneurship. The first cluster (green) includes keywords such as *environmental sustainability*, *climate change*, *environmental protection*, and *competition*, suggesting that ecological imperatives remain at the heart of the discourse. These terms reflect the theoretical backbone of green entrepreneurship—emphasizing the moral and ecological responsibilities of entrepreneurs [16], [17]. The presence of terms like *competition* within this cluster also suggests that market dynamics are being examined in relation to ecological constraints, bridging environmental ethics and economic pragmatism. The second cluster (red) revolves around *innovation*, *green economy*, *green entrepreneurial orientation*, *policy making*, and *environmental economics*. This strand of literature explores how green entrepreneurship intersects with innovation systems, regulatory environments, and economic structures. Scholars in this cluster often examine how policy incentives, institutional support, and innovative capacity determine the success of green ventures. This aligns with work by [18], [19] that highlights the need for enabling environments to nurture green innovation. The third cluster (blue) includes *sustainable entrepreneurship*, *ecopreneurship*, and *entrepreneurship education*. These keywords represent conceptual and educational debates within the field. While “green entrepreneurship,” “ecopreneurship,” and “sustainable entrepreneurship” are often used interchangeably, their subtle differences are being increasingly theorized. Ecopreneurship typically emphasizes ecological motivation, whereas sustainable entrepreneurship balances economic, social, and environmental dimensions. Meanwhile, entrepreneurship education is a relatively newer theme, gaining momentum as universities and training institutions integrate sustainability into their curricula. This highlights a shift in focus from macro-level policy and economic structures to micro-level capability building.

Temporal Evolution and Emerging Themes

The overlay and heatmap visualizations offer insights into the temporal evolution of research themes. Keywords like *green entrepreneurship* and *sustainable development* have remained consistent focal points across the time frame, reflecting their foundational status. However, keywords shaded in yellow—such as *green innovation*, *entrepreneurship education*, and *green entrepreneurial orientation*—indicate a recent surge in scholarly interest. These emerging terms suggest a growing attention to individual entrepreneurial behavior, educational interventions, and innovation as tools to operationalize green transitions. Interestingly, terms like *policy making* and *economic development* are less prominent in recent years, which could suggest either a maturing understanding of their roles or a temporary shift in attention. Alternatively, scholars may now be embedding policy discussions within broader innovation and capability-building frameworks. Furthermore, the rising interest in entrepreneurship education reflects a normative shift in academic and policy circles that prioritize capacity building and values-driven entrepreneurship as key levers for sustainability.

Integration, Gaps, and Future Research

The findings reveal that green entrepreneurship is an inherently interdisciplinary field, drawing from environmental science, economics, innovation studies, and educational theory. However, the fragmented nature of clusters and limited integration between them suggest a need for deeper conceptual consolidation. For instance, there remains ambiguity in the use of terms like *sustainable entrepreneurship* versus *green entrepreneurship*. Future work should aim to develop clearer typologies and conceptual boundaries to enhance theoretical coherence. Another gap is the limited attention to the Global South in mainstream clusters. While countries like India and China are well-represented, many low-income and climate-vulnerable countries remain underexplored. Research should explore how

green entrepreneurship manifests in informal economies, rural settings, and under-resourced communities. Topics like gender, indigenous knowledge, and frugal innovation also warrant greater attention, especially within the context of climate justice and inclusive sustainability. In addition, quantitative dominance in current literature calls for more qualitative and mixed-methods studies. While bibliometric and econometric methods are invaluable for mapping and evaluation, grounded studies that explore lived experiences, motivations, and barriers faced by green entrepreneurs can offer richer insights. Longitudinal studies tracing the evolution of green ventures, comparative analyses across regulatory regimes, and impact assessments of green entrepreneurship programs are all promising directions.

4. CONCLUSION

This study conducted a comprehensive bibliometric and co-word mapping analysis to explore the structure and evolution of scholarly literature on green entrepreneurship. The findings underscore that green entrepreneurship and sustainable

development are the two most dominant and interlinked themes in the field, serving as conceptual anchors across diverse research clusters. Through the identification of co-authorship and co-occurrence patterns, we revealed a dynamic knowledge structure with significant contributions from scholars in Europe, Asia, and the Americas. Thematic clusters reveal an interdisciplinary convergence involving environmental sustainability, innovation, policy-making, and entrepreneurship education. Temporal visualizations suggest a growing focus on emerging themes such as *green innovation*, *entrepreneurial orientation*, and *entrepreneurship education*, reflecting a shift toward actionable and capacity-driven perspectives in recent years. However, challenges remain in the form of conceptual overlaps, limited South-South collaboration, and underrepresentation of grassroots and marginalized perspectives. Future research should aim for greater theoretical clarity, regional inclusiveness, and methodological diversity. Strengthening collaborative networks and incorporating real-world case studies will further enrich the development of green entrepreneurship as both a scholarly field and a transformative societal force.

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