MAPPING SUSTAINABLE ENTREPRENEURSHIP RESEARCH IN THE CONTEXT OF CLIMATE CHANGE: A BIBLIOMETRIC ANALYSIS

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Abstract: ***Climate change presents escalating environmental and socio-economic challenges, increasing attention to entrepreneurship as a pathway for sustainability transitions. Sustainable entrepreneurship has emerged as a mechanism through which entrepreneurial activity contributes to climate mitigation, adaptation, and sustainable development. Despite growing scholarship, research linking sustainable entrepreneurship and climate change remains fragmented. This study employs a bibliometric approach to map the development and intellectual structure of this field using 173 peer-reviewed articles indexed in Scopus and Web of Science. Performance analysis and science mapping techniques implemented in Bibliometrix and VOSviewer are applied to identify publication trends, influential sources, geographic patterns, and thematic clusters. The findings show a marked increase in research output since 2020 and a concentration of publications in sustainability-oriented journals, with strong contributions from climate-vulnerable and emerging economies. Thematic results indicate a shift toward climate-focused streams, including green entrepreneurship, environmental governance, policy frameworks, and green innovation pathways. The study offers a structured overview of the field and identifies key directions for sustainability research and practice.***

• Keywords: *sustainable entrepreneurship; climate change; green entrepreneurship; climate risk; bibliometric analysis.*

Date of receipt: 25th Feb., 2026 *Date of receipt revision: 10th Mar., 2026*
Date of delivery revision: 04th Mar., 2026 *Date of approval: 27th Mar., 2026*
DOI: https://doi.org/10.71374/jfar.v26.i2.20

1. Introduction

Climate change has become one of the most critical global challenges, with widespread negative impacts on environmental systems, economic stability, and social well-being. Rising temperatures, extreme weather events, ecosystem degradation, and increasing environmental risks have intensified uncertainty across regions and industries, particularly in climate-vulnerable economies (Middermann et al., 2020; Karadayı et al., 2025). These changes not only threaten natural resources but also disrupt production systems, livelihoods, and long-term development prospects. Consequently, climate change is increasingly viewed as a complex societal challenge that requires coordinated responses across policy, business, and entrepreneurship. In response to these challenges, governments and international organisations have introduced a wide range of climate-related policies aimed at mitigation and adaptation. National climate strategies, green growth agendas, and sustainability frameworks aligned with the Sustainable Development Goals (SDGs) emphasise the need for economic transformation toward low-carbon and environmentally responsible development pathways (Ike, 2025). However, policy interventions alone are insufficient to address the scale of climate change. Their effectiveness largely depends on how economic actors, particularly firms and entrepreneurs, respond to environmental risks and integrate sustainability objectives into their activities.

At the firm level, the adoption of sustainable business models and green innovation has emerged as a key mechanism through which climate policies are implemented in practice. Companies are increasingly encouraged to embed environmental and social considerations into their strategies, operations, and value creation processes in order to reduce environmental impacts while maintaining competitiveness (Lüdeke-Freund, 2020). Empirical evidence suggests that sustainability-oriented business practices can support climate mitigation efforts, enhance organisational resilience, and contribute to broader sustainability transitions by reshaping production, consumption, and innovation systems (Shmelev & Gilardi, 2025). In this sense, firms play an active role in translating policy ambitions into tangible climate-related outcomes. Beyond established corporations, sustainable entrepreneurship has gained growing attention as a strategic response to climate change. Sustainable entrepreneurship is no longer seen merely as a trend but as a practical solution adopted by new ventures from their inception. Sustainable entrepreneurs deliberately design business models that integrate

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economic performance with environmental protection and social value creation, thereby addressing current sustainability challenges while considering the needs of future generations (Lüdeke-Freund, 2020). In climate-threatened contexts, such as vulnerable communities and emerging economies, sustainable entrepreneurship has also been shown to support local adaptation and resilience by fostering innovation and environmentally responsible practices (Pricopoaia et al., 2024).

The academic literature on sustainable entrepreneurship has expanded rapidly over the past two decades. Research has examined a wide range of topics, including sustainable business models, entrepreneurial competencies, innovation strategies, corporate social responsibility, and entrepreneurial intentions (Lüdeke-Freund, 2020). Several systematic reviews and conceptual studies have sought to synthesise this growing body of knowledge and clarify the conceptual boundaries of sustainable entrepreneurship (Sreenivasan & Suresh, 2023; Ike, 2025). More recent studies have explicitly linked sustainable entrepreneurship to climate change, environmental risk exposure, and sustainability transitions, highlighting the influence of climate uncertainty on entrepreneurial decision-making and opportunity recognition (Middermann et al., 2020; Karadayı et al., 2025).

Despite these advances, the literature remains fragmented. Existing studies often focus on specific dimensions, such as entrepreneurial intention, innovation, education, or policy support, without offering an integrated view of how sustainable entrepreneurship research has evolved in relation to climate change. Moreover, most prior reviews rely on qualitative or narrative synthesis and provide limited insights into publication trends, thematic structures, and knowledge networks within the field. As a result, there is still a lack of comprehensive, data-driven overviews that systematically map the intellectual structure of sustainable entrepreneurship research in the context of climate change. To address this gap, the study conducts a bibliometric analysis of the literature on sustainable entrepreneurship and climate change. Using data from the Scopus and Web of Science databases, this study systematically maps publication trends, influential sources, geographic and institutional contributions, and thematic structures through bibliometric techniques. The results provide an integrated overview of how sustainable entrepreneurship research has developed in response to climate-related challenges and identify key themes, emerging research directions, and underexplored areas.

The main contribution of this study is to provide a structured bibliometric overview of sustainable entrepreneurship research in the context of climate change. By analysing publication trends and thematic patterns, the study complements existing qualitative reviews and clarifies how entrepreneurship research contributes to climate resilience and sustainable development. The findings offer relevant insights for researchers, policymakers, and educators promoting sustainability-oriented entrepreneurship under environmental uncertainty.

The remainder of the paper is organised as follows. Section 2 describes the data collection and bibliometric procedures. Section 3 presents the results on publication trends and thematic structures. Section 4 discusses the implications of the findings. Section 5 concludes with key insights, limitations, and future research directions.

2. Materials and Methods

This study employs a bibliometric research design to map how the literature on sustainable entrepreneurship has developed in the context of climate change and environmental risk. Bibliometric analysis is particularly suitable when a field is interdisciplinary and conceptually diverse, as it provides a systematic and transparent way to synthesise publication patterns and knowledge structures using bibliographic metadata (Aria & Cuccurullo, 2017; Donthu et al., 2021). In line with established bibliometric practice, the study combines descriptive performance indicators with science-mapping techniques to examine both the growth of the literature and the way key concepts cluster and connect over time (Zupic & Čater, 2015).

Data sources and search strategy

Bibliographic records were retrieved from Scopus and Web of Science (WoS), which are widely regarded as authoritative databases for peer-reviewed research in sustainability, environmental studies, and management. Their structured indexing and metadata consistency make them appropriate for bibliometric mapping, compared with broader databases that may contain inconsistent records. A unified keyword strategy was applied across the two databases to capture core conceptual variants of sustainable entrepreneurship and explicitly link them to climate-related issues. In Scopus, the search was conducted in TITLE-ABS-KEY, while in WoS it was conducted in the Topic (TS) field.

The query combined (i) entrepreneurship-related terms (e.g., "sustainable entrepreneurship", "green entrepreneurship", "environmental entrepreneurship", "eco-entrepreneurship", and "sustainability-oriented entrepreneurship", including a truncation-based expression for "sustainable enterprise*" linked to entrepreneur*) with (ii) climate-related terms (e.g., "climate change", "climate risk*", "climate uncertainty", "climate resilience", "environmental uncertainty", and "environmental risk*") using Boolean operators. The initial search yielded 134 records from Scopus and 97 from WoS (231 in total).

Inclusion and exclusion criteria

To ensure analytical reliability and comparability, the dataset was restricted to English-language publications classified as journal Articles or Reviews. Records were exported (RIS format), merged, and screened for duplication based on title, author(s), publication year, and source information. A total of 58 duplicate records were removed, resulting in a final dataset of 173 unique documents for analysis. Prior to analysis, a preprocessing step was conducted to standardise keywords and reduce conceptual noise, addressing spelling variants, plural forms, and near-synonyms that refer to the same construct, consistent with recommended procedures in bibliometric research (Donthu et al., 2021). Non-informative or overly generic terms that did not meaningfully represent the focal domain were removed to improve the interpretability of keyword networks.

Bibliometric tools and analytical techniques

The analysis integrates performance analysis and science mapping techniques (Zupic & Čater, 2015; Donthu et al., 2021). Descriptive performance indicators (e.g., annual scientific production, most relevant sources, and country/institution contributions) were produced using Bibliometrix in R, which supports reproducible bibliometric workflows and standard performance metrics (Aria & Cuccurullo, 2017). To examine the conceptual structure of the field, keyword-based science mapping was conducted using both Bibliometrix and VOSviewer. Specifically, a multi-field keyword approach was applied to incorporate terms extracted from titles, abstracts, author keywords, and indexed keywords, thereby broadening conceptual coverage and reducing the risk of field-specific keyword omissions. Keyword co-occurrence networks were constructed using full counting, and visualisation and clustering were performed in VOSviewer, which applies association-strength normalisation and a modularity-based clustering algorithm to identify coherent thematic clusters (van Eck & Waltman, 2010). Finally, trend topic analysis was used to examine how prominent themes have shifted over time, providing a temporal view of evolving research attention within the sustainable entrepreneurship-climate change literature (Donthu et al., 2021).

3. Results

3.1. Publication trends and sources analysis

Figure 1 shows the annual scientific production of publications related to sustainable entrepreneurship in the context of climate change. The trend indicates a steady increase in the number of publications from the early 2000s, with a noticeable surge from 2020 to 2024. This rise reflects the growing urgency of climate change as a global issue, aligning with increasing scholarly interest in entrepreneurial approaches to addressing environmental risks and sustainability. In the earlier years, the field was marked by occasional studies, as sustainable entrepreneurship was treated as a distinct concept within broader environmental and business research. More recently, the volume of publications has increased significantly, signaling the growing consolidation of sustainable entrepreneurship as a central response to climate change.

This acceleration in publication volume aligns with findings by Karadayı et al. (2025), where the literature on sustainable entrepreneurship has gained more prominence in response to escalating climate challenges. The surge in research output reflects a growing recognition of the role of entrepreneurship in fostering climate adaptation and resilience, particularly as policy frameworks like the Paris Agreement and the SDGs push for innovative, entrepreneurial solutions to climate change (Sreenivasan & Suresh, 2023).

Figure 1: Annual scientific production of publications on sustainable entrepreneurship and climate change

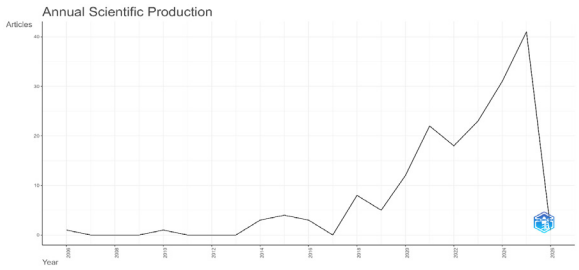


Figure 2 displays the most relevant sources publishing on sustainable entrepreneurship and climate change. The distribution indicates that research in this field is predominantly published in journals focusing on sustainability, environmental management, and business strategy. Sustainability leads the list with

fourteen articles, followed by Business Strategy and the Environment and Journal of Cleaner Production, each contributing five papers. This trend highlights the increasing intersection of entrepreneurship with sustainability, environmental management, and policy, reflecting the interdisciplinary nature of the field (Lüdeke-Freund, 2020). The dominance of sustainability-related journals underscores the growing importance of environmental issues within entrepreneurship research.

Figure 2: Most relevant sources and their publication count

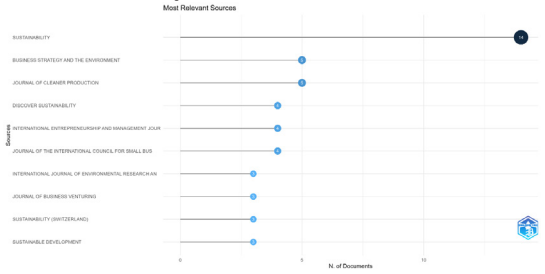
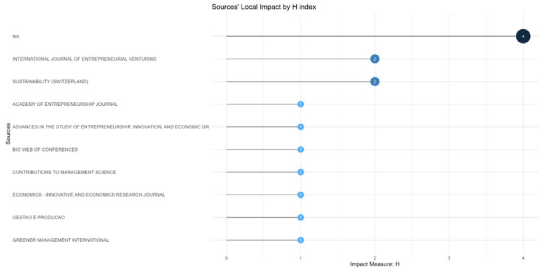


Figure 3 further explores the sources' local impact, measured by the H-index. The H-index is a measure of both the number of publications and the citations each publication receives, providing insight into the academic influence of the journals in this field. In this case, *Sustainability (Switzerland)* and the *International Journal of Entrepreneurial Venturing* show an H-index of 2, indicating that these sources have published a modest number of articles that have received moderate citations, confirming their scholarly impact. However, a significant portion of the sources, 14 in total, have an N/A H-index, indicating either a lack of sufficient citation data or that these journals are too new to have accumulated the necessary citation impact. This underscores the emerging nature of sustainable entrepreneurship research, with some journals still building their citation and scholarly influence. The presence of several sources with an N/A H-index is common in emerging research domains and does not necessarily indicate low quality, but rather reflects limited publication volume or the recency of journal inclusion in citation databases.

These publication and citation patterns indicate the growing visibility of sustainable entrepreneurship within climate change-related research, particularly at the intersection of sustainability, environmental management, and business studies.

The analysis of publication trends and sources reveals that sustainable entrepreneurship research in the context of climate change has evolved from a fragmented niche to a rapidly growing and interdisciplinary area. The increasing volume of publications, particularly in key sustainability journals, reflects the alignment between entrepreneurship and global climate goals. However, the ongoing diversification of sources suggests that the field is still in a developmental phase, with considerable potential for further conceptual and empirical growth.

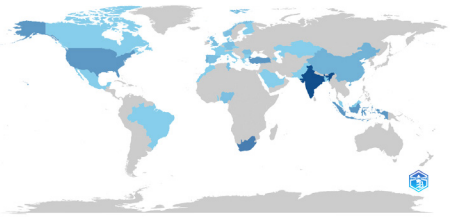
Figure 3: Sources' local impact by H-index



3.2. Geographic distribution and collaboration networks

The geographic distribution of research on sustainable entrepreneurship in the context of climate change shows a clear concentration of scientific output in a limited number of countries, alongside a broad but uneven global spread. Figure 4 illustrates the spatial distribution of country scientific production, revealing that research activity is most visible in South and Southeast Asia, parts of Europe, and selected countries in Africa and the Americas. Among these, India emerges as one of the most prominent contributors, reflected by the highest intensity of publication activity on the map. Substantial research output is also observed in the United States, Turkey, China, Indonesia, Brazil, and South Africa, indicating that scholarly attention to sustainable entrepreneurship and climate change is particularly strong in regions facing simultaneous pressures related to economic development and environmental vulnerability.

Figure 4: Country scientific production of publications on sustainable entrepreneurship and climate change

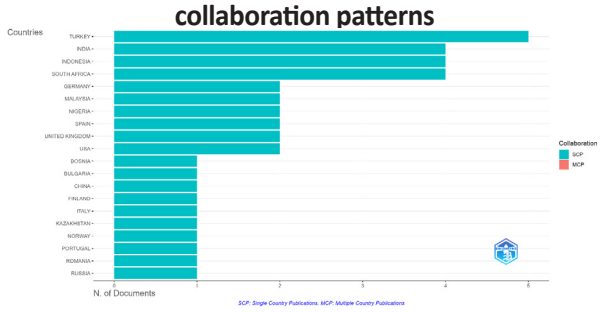


While country-level production captures overall research output, the distribution of corresponding authors' countries provides further insight into research leadership. As shown in Figure 5, Turkey records the highest number of corresponding authors,

followed closely by India, Indonesia, and South Africa. This pattern suggests that scholars based in these countries are not only active contributors but also frequently assume leading roles in shaping research directions within this field (Audretsch et al., 2021). In contrast, countries such as Germany, Malaysia, Nigeria, Spain, the United Kingdom, and the United States appear with more moderate levels of corresponding authorship, indicating a more supportive or collaborative role rather than primary leadership.

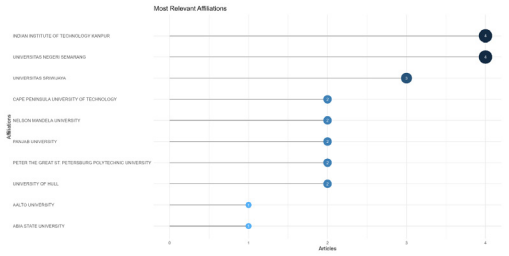
The collaboration profile further reveals that the majority of publications are classified as single-country publications (SCP), with relatively limited instances of multi-country publications (MCP) (Figure 5). The dominance of SCP across most contributing countries points to a research landscape that remains largely nationally embedded (Audretsch et al., 2021). This pattern reflects the context-specific nature of sustainable entrepreneurship research, where empirical investigations are often grounded in domestic institutional frameworks, policy environments, and socio-economic conditions associated with climate change. At the same time, the relatively low level of international co-authorship suggests that cross-border collaboration in this research area is still developing.

Figure 5: Corresponding authors' countries and collaboration patterns



At the institutional level, publication output is widely dispersed rather than concentrated within a small group of dominant universities. Figure 6 presents the most relevant affiliations, showing that institutions such as the Indian Institute of Technology Kanpur and Universitas Negeri Semarang are among the most productive, followed by Universitas Sriwijaya and several universities based in South Africa and Europe, including the Cape Peninsula University of Technology and Nelson Mandela University. This distribution indicates that knowledge production on sustainable entrepreneurship and climate change is driven by a diverse set of academic institutions across different regions.

Figure 6: Most relevant affiliations in sustainable entrepreneurship and climate change research



3.3. Keyword co-occurrence and thematic clusters

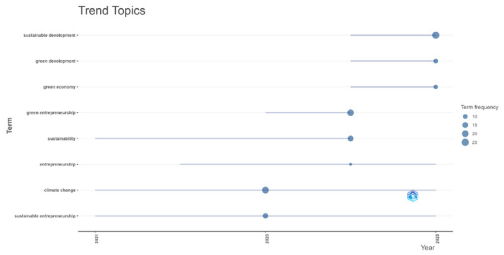
The intellectual structure of sustainable entrepreneurship research in the context of climate change is further clarified through keyword-based analyses, including trend topics, keyword frequency distributions across different metadata fields, and keyword co-occurrence networks. These analyses reveal both the conceptual foundations of the field and its recent thematic shifts toward climate-oriented and policy-relevant research agendas.

Figure 7 illustrates the temporal evolution of dominant research topics through trend topic analysis. Early studies in the dataset are primarily anchored in broad concepts such as sustainability and entrepreneurship, reflecting the formative stage of the literature where sustainable entrepreneurship was discussed largely as an extension of general sustainability and business research. From around 2023 onward, the prominence of climate change and sustainable entrepreneurship increases noticeably, indicating a clearer alignment between entrepreneurial activity and climate-related challenges. More recent years show the emergence and growing visibility of terms such as green economy, green development, and green entrepreneurship, suggesting a shift from conceptual discussions toward more applied and policy-relevant themes (Karadayı et al., 2025). This progression points to an expanding research focus on how entrepreneurial initiatives contribute to green transitions, climate mitigation, and sustainable development pathways rather than sustainability in a generic sense.

While trend topics capture temporal dynamics, the semantic emphasis of the literature is further differentiated when examining keyword distributions across different document components. Figure 8 compares the most frequent terms appearing in title keywords, abstract keywords, author keywords, and keyword plus. Title keywords are dominated by core concepts such as *sustainable entrepreneurship*, *green entrepreneurship*, and *sustainability*, indicating that

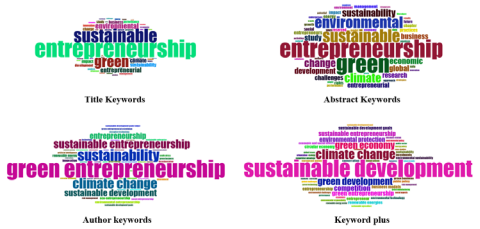
authors frame their contributions explicitly within the sustainable entrepreneurship discourse. Abstract keywords, however, display a broader thematic range, with strong visibility of *environmental*, *climate change*, *economic development*, and *green*, reflecting efforts to situate individual studies within wider environmental and socio-economic debates.

Figure 7: Trend topics in sustainable entrepreneurship and climate change research



Author keywords reveal a more focused and intentional representation of research priorities. Alongside *sustainable entrepreneurship* and *green entrepreneurship*, terms such as *climate change*, *sustainable development*, and *renewable energy* appear frequently, signaling deliberate attempts by authors to connect entrepreneurial activity with climate action and long-term development goals. In contrast, keyword plus, automatically generated from cited references, places stronger emphasis on *sustainable development*, *green economy*, and *environmental protection*. This pattern suggests that while authors increasingly foreground climate-oriented entrepreneurship in their own framing, the underlying knowledge base of the field remains closely tied to broader sustainable development and environmental economics literatures. The divergence between author keywords and keyword plus thus highlights an ongoing transition from general sustainability research toward a more distinct climate-entrepreneurship nexus (Lüdeke-Freund, 2020).

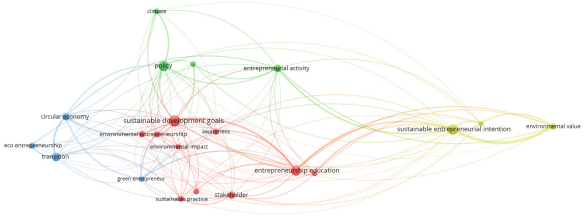
Figure 8: Keyword distribution across title keywords, abstract keywords, author keywords, and keyword plus



The structural relationships among key concepts are visualized in the keyword co-occurrence network shown in Figure 9. The network reveals several interconnected thematic clusters that define the current landscape of research. One central cluster revolves around *sustainable development goals*, *environmental impact*, and *environmental entrepreneurship*, underscoring the normative and outcome-oriented orientation of the literature. Closely linked to this core is a policy-oriented cluster, where *policy*, *entrepreneurial activity*, and *climate* form dense connections, reflecting growing interest in the role of institutional frameworks and public policy in enabling sustainable entrepreneurial practices.

Another prominent cluster focuses on *entrepreneurship education*, *stakeholders*, and *sustainable practice*, highlighting the importance of human capital development, awareness, and multi-actor engagement in fostering sustainability-oriented ventures. A further cluster, centered on *sustainable entrepreneurial intention* and *environmental value*, points to an emerging micro-level research stream that examines motivational drivers, values, and behavioral intentions related to sustainable entrepreneurship. Finally, a smaller but distinct cluster around *circular economy*, *eco-entrepreneurship*, and *transition* reflects increasing attention to systemic change and circular business models as mechanisms for addressing climate challenges.

Figure 9: Keyword co-occurrence network and thematic clusters in sustainable entrepreneurship and climate change research



The keyword analyses demonstrate that sustainable entrepreneurship research has evolved from a broad sustainability discourse into a more differentiated field with clear thematic streams. The increasing prominence of climate-related terms, policy linkages, and intention-based perspectives indicates a shift toward actionable research that connects entrepreneurial processes with climate mitigation, adaptation, and sustainability transitions. These patterns reinforce the positioning of sustainable entrepreneurship not merely as a normative ideal but as a practical mechanism for addressing climate change across multiple levels of analysis.

4. Discussion

The bibliometric findings show that sustainable

entrepreneurship has become an increasingly central lens within climate change-related research. The steady growth in publications and the diversification of thematic emphases indicate that the field has moved beyond a peripheral sustainability topic toward a more consolidated area of inquiry addressing climate risks, environmental challenges, and development pathways.

The expansion of the literature after 2020 aligns with intensified global attention to climate mitigation and adaptation. Within this context, entrepreneurship is increasingly framed as a complementary mechanism to regulatory and technological responses, capable of mobilising innovation, local knowledge, and market-based solutions. Growing attention to green technologies and sustainability-oriented innovation further highlights the role of entrepreneurs as intermediaries translating technological possibilities into scalable climate solutions.

Geographic patterns suggest that sustainable entrepreneurship is particularly salient in emerging and climate-vulnerable economies, where development pressures intersect with environmental risks. The dominance of single-country studies underscores the importance of institutional and regulatory contexts in shaping entrepreneurial responses. Variations in policy coherence, governance capacity, and access to climate-related support mechanisms appear to influence both research attention and practical opportunities for sustainable entrepreneurship.

Thematic analyses reveal a shift from general sustainability narratives toward stronger engagement with climate policy frameworks and environmental governance. Sustainable entrepreneurship is increasingly examined within broader governance systems, where climate policy instruments, such as regulatory standards, green finance, and innovation incentives, shape entrepreneurial orientation toward mitigation and adaptation objectives. This perspective positions entrepreneurs as active contributors within multi-actor climate governance arrangements.

At the same time, the coexistence of policy-level, organisational, and individual-level themes, including education, entrepreneurial intention, environmental values, and circular economy, reflects the multidimensional nature of the field. Such diversity aligns with sustainability transitions research, where entrepreneurship is viewed as a niche-level force supporting broader socio-technical transformation toward low-carbon and climate-resilient systems.

5. Conclusion and Implications

This study provides a bibliometric overview of sustainable entrepreneurship research in the context of climate change, highlighting its rapid expansion, increasing interdisciplinarity, and stronger integration with sustainability transitions and development agendas. The findings confirm that sustainable entrepreneurship has become an important analytical lens for understanding entrepreneurial responses to climate-related uncertainty.

The results offer several implications. For researchers, the mapping of trends, geographic patterns, and thematic clusters clarifies the evolution of the field and identifies underexplored areas, particularly cross-country comparisons and institutional influences. For policymakers, the prominence of governance- and policy-related themes underscores the importance of coherent climate frameworks, green innovation support, and sustainability-oriented finance in enabling entrepreneurial responses to environmental challenges. For educators, the emphasis on entrepreneurial intention, competencies, and sustainable business models highlights the need to embed climate awareness and sustainability principles in entrepreneurship education.

The study is limited to English-language journal articles indexed in Scopus and Web of Science, and bibliometric methods capture structural patterns rather than detailed content. Future research could expand database coverage and combine bibliometric mapping with qualitative or comparative approaches to deepen understanding of how sustainable entrepreneurship contributes to climate mitigation and adaptation across diverse contexts.

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