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Climate Change and Entrepreneurship: A Review and Research Agenda

Talha Karadayi[1] | Selim Yazici[2] | Gökçe Akdemir Omur[2]

[1]Faculty of Business, Department of Management Information System, Istanbul Ticaret University, Istanbul, Turkey | [2]Faculty of Political Sciences, Department of Business Administration, Istanbul University, Istanbul, Turkey

Correspondence: Talha Karadayi (tkaradayi@ticaret.edu.tr)

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ABSTRACT

As climate change risks intensify, the role of entrepreneurial activities in addressing these challenges and promoting sustainable development becomes increasingly vital. Through a systematic literature review using a bibliometric analysis of 387 studies from Scopus up to December 31, 2023, this study focuses on the intersection of entrepreneurship and climate change. It contributes to academic understanding by offering insights into current trends for entrepreneurs, researchers, and policymakers. Our analysis examines publication trends, leading authors, countries/regions, and common themes to elucidate research efforts on entrepreneurial activities in the context of climate change. Contrary to typical trends in the geographical distribution, the study identifies a significant increase in contributions from developing countries such as China, India, and the Russian Federation. Furthermore, when evaluating entrepreneurship in the context of climate change, we observe a prominence of innovation and sustainability-focused approaches. The primary finding of the study is the literature's attribution of significant responsibility to entrepreneurship in combating climate change and its consideration of entrepreneurship as a prerequisite for sustainable approaches. By demonstrating a sustainable attitude, entrepreneurs can contribute to the fight against climate change across various domains, ranging from policy to social life, and from collective efforts in the economy to individual endeavors.

1 | Introduction

As each season unfolds, the Earth undergoes dynamic changes in weather patterns, raising concerns about plant and animal health. Average weather patterns worldwide have undergone significant transformations, especially since the turn of the millennium (Ojo and Oluwatayo 2023). The chilling reality of climate change, fueled by the impact of human activities on nature, has reached an undeniable tipping point.

Across the globe, people witness the intensification of storms, floods, and forest fires. Tens of millions are exposed to the perils of air pollution, threatening their health. Unpredictable weather patterns endanger housing and economic security (United Nations Climate Change Conference 2021). As the Intergovernmental Panel on Climate Change (IPCC 2021) starkly outlines, human-induced climate change leads to soil water loss, intensifying agricultural, and ecological droughts in some regions and undermining food production. Meanwhile, the World Health Organization (WHO 2021) reports that climate change disrupts hydrological systems and freshwater resources, jeopardizing terrestrial and marine ecosystems, and triggering land degradation, biodiversity loss, and ocean acidification.

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Summary

- Climate change is a pressing issue for humankind, with activities to combat it and other global environmental risks playing a crucial role in shaping our future. Entrepreneurship can serve as a valuable tool in this fight, generating long-term and sustainable solutions for both society and the environment. This study yields three key insights:
  - *For entrepreneurs*: Climate change's widespread effects are evident globally. Entrepreneurs, regardless of their profit motives, must acknowledge this reality. They should prepare for climate change's impacts and recognize the opportunities it presents for much-needed advancements. Clean technologies, innovative products, and ecologically conscious processes will influence entrepreneurs' strategic decisions and investments. Thus, this study provides valuable guidance on where future investments should be directed and identifies pressing issues requiring solutions. Additionally, by analyzing development trends over the years, it offers predictive insights for entrepreneurs.
  - *For academics*: This bibliometric analysis of "Climate Change" and "Entrepreneurship" provides fresh data for researchers. By mapping the distribution of academic publications on this subject across different countries and regions and highlighting emerging research topics, it sheds light on new avenues for academic inquiry.
  - *For policymakers*: This study illustrates shifts in academic interest, regional significance, and prevailing concepts. It offers valuable insights and projections for policymakers crafting regulations, particularly regarding climate change and its economic implications on both regional and global scales. By integrating climate change with entrepreneurship, this research can inform decisions affecting economic activities.

The World Economic Forum (WEF 2021) emphasizes the criticality of achieving a 9% annual reduction in carbon emissions over the next decade to align with the Paris Agreement's goal of limiting global warming to 1.5°C. This ambitious target is crucial for avoiding the catastrophic consequences of climate change. This underscores the critical need for a concerted global preventative effort. Climate change is not merely an environmental threat; it is a global crisis, menacing fundamental necessities such as water, energy, food, and clean air (Oyelola, Babatunde, and Abiodun 2011).

In addressing environmental risks, it is essential for all members of society, including corporations, policymakers, entrepreneurs, academics, and nongovernmental organizations, to assume responsibility. They must collaboratively formulate effective measures, policies, and resource management strategies, considering global risks, alarming data, and future projections (De Amorim et al. 2018). Collective efforts are crucial in navigating the challenges posed by acknowledging the diversity of risks and responding effectively to irrefutable data.

Air pollution, accelerating climate change, and other global risks loom large over our planet. However, a potential solution emerges amidst this concerning reality: sustainable approaches. Renewable energy sources, notably favored in sustainable solutions, occupy a leading role, outlining a practical route toward a cleaner and more environmentally friendly future. However, the pursuit of sustainability requires more than just technological advancements; it demands a fundamental shift propelled by an entrepreneurial mindset.

In recent years, sustainable entrepreneurship has blossomed from a niche concept to a vital force in the global conversation on sustainability. Entrepreneurs are increasingly recognized as critical actors in enabling sustainable innovations in products and processes, ultimately contributing to a smoother transition toward a more sustainable world (Ali et al. 2023). These entrepreneurs go beyond profit generation; they seek to solve social and environmental problems through their core operations. Sustainable entrepreneurs minimize their environmental footprint and integrate sustainability principles into their business models (Kooijman et al. 2021). This pursuit of sustainable value, encompassing economic, ecological, and social dimensions, defines the very essence of this nascent field.

In this context, climate-focused entrepreneurs and startups play a crucial role. These innovative ventures, designed to address specific climate and environmental challenges, act as catalysts for change, propelling us toward the goals outlined in the 2030 Agenda for Sustainable Development (Apostolopoulos et al. 2018; Melati 2021). The Sustainable Development Goals (SDGs) established by the United Nations (UN) provide a comprehensive framework for tackling the social, environmental, and economic issues plaguing our planet. Recognizing the transformative power of business innovation, the UN actively promotes entrepreneurship as a critical driver of achieving the SDGs (Azmat et al. 2023; Melati 2021).

Countries and policymakers actively engaged in combating climate change can enhance their focus on the issue. Demonstrating solid determination creates a crucial incentive, fostering heightened attention, and urgency in addressing the challenges posed by climate change. Ambitious goals and regulations, such as the European Union's climate action policies and the SDGs, not only set clear goals but also incentivize the development of environmentally friendly technologies and sustainable entrepreneurial ventures (Ruiz, Martín, and Prados-Castillo 2023). With suitable support systems in place, entrepreneurship has the potential to pave the way for a genuinely sustainable future (Hameed et al. 2023).

The escalating impact of entrepreneurial activities on regional and global scales (UN 2020) draws researchers' attention closer to this dynamic field, bridging disciplinary gaps, and sparking fresh perspectives (Akinbami 2021b; Ranjan 2015). This surge in academic interest coincides with the growing urgency of addressing climate change, driving explorations into how entrepreneurship and innovation can serve as powerful tools for mitigation and adaptation.

Research in this domain delves into how entrepreneurship and innovation contribute to climate change mitigation and

adaptation. It also examines entrepreneurs' and businesses' opportunities and challenges in the burgeoning green economy. Hence, it is essential to understand the relationship between "entrepreneurship" and "climate change," including its focus, development, and current status within the academic realm. However, relying solely on a systematic review may not suffice for comprehending the quantitative aspects of this field (Mishra and Pandey 2023). Following the recommendation of Donthu et al. (2021), a bibliometric analysis would be fitting to assess the academic contributions and encompass the quantitative dimension. Consequently, this article offers a comprehensive overview of the academic contributions to the intersection of entrepreneurship and climate change. By integrating scholarly works, the goal is to shed light on diverse perspectives, highlight evolving trends, and address contemporary issues. Additionally, the paper aims to pose relevant research questions, guiding future scholars exploring this academic domain.

Bibliometric research holds immense potential to bridge the gap between theory and practice. Leading publications across diverse disciplines are increasingly featuring impactful studies driven by bibliometric techniques (Mukherjee et al. 2022). Hence, a bibliometric review of the intersection between entrepreneurship and climate change, a topic witnessing an alarming rise in academic interest (Ojo and Oluwatayo 2023), offers valuable insights for entrepreneurs, academics, and policymakers. By analyzing publication trends, leading authors, geographic distribution, co-occurring keywords, and the popularity of keywords by year, this review aims to achieve the following:

- *Inspire entrepreneurs*: Identify promising investment opportunities and emerging trends based on the latest research.
- *Guide researchers*: Provide a comprehensive view of the field, highlighting gaps and suggesting directions for future research.
- *Inform policymakers*: Direct attention to crucial areas that demand policy intervention and support for innovative climate solutions.

While the first mention of entrepreneurship alongside climate change in academic literature dates back to 2001, the field has blossomed recently. A meager total of four publications in 2011 impressively increased to 76 by 2023. However, bibliometric studies dissecting this surge still need to be made available. This review aims to fill this void by offering a data-driven exploration of this burgeoning field. Therefore, this paper has the following research questions:

- RQ1: What are the publication trends observed in research on climate change and entrepreneurship?
- RQ2: Who are the primary contributors (authors and countries/territories) to research on climate change and entrepreneurship?
- RQ3: What insights do existing studies (themes, topics) provide into the intersection of climate change and entrepreneurship?
- RQ4: How have the primary themes and associated trending topics evolved over time within the realm of climate change and entrepreneurship research?

The study initiates Section 2 by scrutinizing the positioning of climate change on the global agenda. Subsequently, it elucidates the inherent connection between the challenges presented by climate change and the realm of entrepreneurship. This section sets the stage for the subsequent analysis. Section 3 meticulously outlines the research design and methodology employed in the study. The chosen methods and approaches are clearly explained. Section 4 presents the results of the research, detailing the findings obtained through the selected methodologies. This section provides the factual foundation for subsequent interpretation and discussion. Section 5 meticulously interprets the significance of the findings for climate change and entrepreneurship research, shedding light on the study's theoretical implications by exploring emerging data, themes, and trends. In addition, this section underscores the practical implications for academics, entrepreneurs, and policymakers. It furnishes concrete takeaways and actionable recommendations tailored for each stakeholder group, urging them to leverage the research findings for further progress in addressing the interconnected challenges of climate change and sustainable development. In addition, it underlines the study's limitations and paves the way for future research. Finally, Section 6 concludes the study by synthesizing the essential findings and presenting the work as a cohesive whole.

2 | Literature Review

2.1 | Global Agenda on Climate Change: A Review of Risks, Failures, and Imperatives

The 19th century ushered in a dramatic escalation of human influence on the climate, largely driven by the rapid spread of industrialization. This impact is evident in numerous concerning trends: record-breaking air, land, and ocean temperatures; a surge in atmospheric CO_2 concentration; the alarming retreat of ice sheets and glaciers; rising sea levels; and a global average temperature increase exceeding 0.2°C per decade (IPCC 2018, 2021).

International organizations have closely monitored the rising tide of environmental risks associated with climate change, including temperature fluctuations, extreme weather events, and ecosystem degradation. Notably, the annual "Global Risks Perception Surveys" by WEF (2021) reveal "Climate Action Failure" as a persistent top-tier economic risk since the early 2010s. The 2023 Global Risk Report further emphasizes this threat, placing "Failure to mitigate climate change" at the very forefront of potential global risks due to its immense destructive impacts (WEF 2023). Two additional, prominent risks highlighted in the 2023 report are "Failure of climate-change adaptation" and "Natural disasters and extreme weather events," both inextricably linked to global warming as a part of climate change (Oyelola, Babatunde, and Abiodun 2011; WEF 2023).

The key reason why climate change constitutes a global crisis is that its effects transcend regional boundaries, resulting in worldwide consequences (Embry, Jones, and York 2019). Developing nations contribute comparatively less to the critical climate change threshold than their developed counterparts. However, their heightened vulnerability to extreme environmental events exposes them to substantial damage and disasters. The disparities

in vulnerability highlight the need for nuanced, equitable climate policies. Changes in climate in the Northern Hemisphere can directly or indirectly impact regions in the Southern Hemisphere. For instance, an increase in greenhouse gas emissions in China may alter the rainfall per cubic meter in the rainforest (Oyelola, Babatunde, and Abiodun 2011).

Acknowledging the urgent need for a global action plan, countries and scientists recognize that the current efforts have yet to yield optimistic results. Despite scientific consensus and a global search for collaborative solutions, a tangible decline in global warming still needs to be achieved. The landmark Paris Agreement, a multilateral effort under the United Nations Framework Convention on Climate Change (UNFCCC), stands as a testament to the international desire for joint action (UNFCCC 2021). However, its impact on curbing global warming has been underwhelming (WEF 2021). Similarly, the 2021 WHO Health and Climate Change Global Survey with health authorities from 95 countries reveals a dire lack of action. Of the surveyed countries, 48% lack national health and climate change plans or strategies, and of the 46 countries with such plans, only 12 can effectively implement them (WHO 2021).

These stark realities underline the need for a transformative global response that transcends national boundaries and unites all facets of society. Governments, businesses, NGOs, R&D centers, scientists, and entrepreneurs must collaborate to drive change in vital areas: clean technologies, renewable energy, waste reduction, carbon neutrality, and sustainable water management. Their joint efforts are essential for meaningful progress (Cuomo 2011). Only through sustained, unified action can we hope to mitigate the escalating climate crisis and secure a habitable future for generations to come.

2.2 | Entrepreneurship and Climate Change

Entrepreneurship emerges as a key theme in the discourse surrounding concerted efforts—both at the professional and individual levels—to mitigate the impacts of climate change theme. Entrepreneurs, unencumbered by the constraints of traditional hierarchies and bureaucratic structures, often possess the adaptability and ingenuity necessary to address the challenges posed by climate change in innovative ways (Embry, Jones, and York 2019). In this context, entrepreneurs are expected to generate value by explicitly focusing on "climate change" in the 21st century, a period marked by global concerns about the climate crisis. The uncertainties brought by climate change present opportunities for innovation, entrepreneurship, and investment. Entrepreneurs, taking the initiative, can identify opportunities, evaluate, and mobilize resources to capitalize on business prospects related to climate change (Oyelola, Babatunde, and Abiodun 2011).

Hameed et al. (2023), in a comprehensive analysis using data from 45 countries, explore the impact of climate change on entrepreneurship. Their findings underscore a global-level relationship between climate change and entrepreneurship, emphasizing the imperative to formulate policies that promote environmental sustainability through entrepreneurship. This sentiment resonates with Lee and Ahn (2019), who analyze the proactive responses of South Korean businesses to climate challenges through the lens of "climate entrepreneurship." Their findings support the notion that businesses can enhance profitability while maintaining competitiveness by adopting entrepreneurial approaches to climate solutions. Potluri and Phani (2022) echo this, emphasizing the crucial role of green entrepreneurship in driving technological advancements that curb harmful emissions and catalyze global social transformation. They envision a future where linking local and national economic interests through disruptive technology models accelerates the mitigation of environmental challenges. Furthermore, George, Merrill, and Schillebeeckx (2021) focus on sustainable activities driven by digital innovations, particularly those undertaken by entrepreneurs. Their findings highlight that startups led by young entrepreneurs, producing tangible outputs in digital sustainability against climate change and other significant challenges, contribute to socioecological value. These organizations and those that follow suit are predicted to play a central role in industry responses to climate change and other pressing challenges.

While policymakers primarily emphasize entrepreneurship for promoting sustainable and equitable development (Youssef, Boubaker, and Omri 2018), they should prioritize creating robust public policies to enhance environmental awareness and safeguard the natural environment. Concurrently, regulations should incentivize environmentally and socially sustainable models, creating an optimal environment for entrepreneurs to thrive (UN 2020). The success of such policies can lead to the attainment of sustainable environmental goals through entrepreneurship (Hameed et al. 2023).

Malaysia's commitment to the 2030 Agenda for Sustainable Development serves as a successful example. Their implementation of renewable energy policies, technological and financial innovations, and robust entrepreneurial engagement has demonstrably reduced carbon emissions (Philip, Emir, and Udemba 2022). However, positive examples like Malaysia are scarce, with many countries, particularly in Asia and the Pacific, reporting challenges in achieving the 2030 Agenda for Sustainable Development (Lim 2022). As the Malaysian case study illustrates, policymakers worldwide must prioritize the formulation of policies that incentivize climate-focused entrepreneurship and industries (Kaesehage et al. 2019; UN 2020). Practical models for action are evident in initiatives such as the European Entrepreneurial Region (EER) project. It categorizes regions based on resource potential, providing incentives for sustainable businesses aligned with the SDGs. Similarly, the US Global Development Lab's "Development Innovation Ventures" fund supports entrepreneurial solutions for global challenges, including climate change (EER Project; Crecente, Sarabia, and del Val 2021). On the other hand, numerous organizations such as EIT Climate-KIC, the Coalition for Climate Entrepreneurship (CCE), the Aspen Network of Development Entrepreneurs (ANDE), and the International Development Research Centre (IDRC) are also undertaking activities to promote entrepreneurship in response to climate change, engaging entrepreneurs, researchers, and policymakers.

Co-founded by the UN, EIT Climate-KIC supports cities, regions, countries, and industries in achieving their climate goals through systems innovation and place-based transformations, prioritizing the integration of climate action into the entrepreneurial

ecosystem by bridging the gap between climate innovation supply and demand (EIT Climate-KIC 2024). Operating as a public-private partnership, CCE, supported by the US Department of State's Office of Global Partnerships (GP), aims to scale climate-focused entrepreneurship globally. Its objective is to attract investment in climate initiatives, make climate-focused ventures worth investing in, and enhance economic empowerment in developing nations. To achieve this, CCE provides vital support to climate ventures, including training, mentorship, and access to capital (CCE 2024). ANDE is a global network that fosters entrepreneurship in developing economies by convening key stakeholders, leveraging resources, and deploying a systems approach to drive collective action toward poverty alleviation and the transition to more inclusive and green economies (ANDE 2024). IDRC funds research and innovation to address global challenges such as climate change and inequality, supporting entrepreneurial solutions that promote sustainable development, gender equality, and economic empowerment in developing countries (IDRC 2024). Under the Amazon Sustainability Accelerator program, Amazon supports startups shaping sustainable innovation in various areas such as circular economy, recycling technology, and more sustainable consumer products, through comprehensive support including monetary grants, mentorship, and educational programs (Amazon 2024).

While the potential of entrepreneurship as a solution to climate change is undeniable (Apostolopoulos et al. 2018; Crecente, Sarabia, and del Val 2021; Kaesehage et al. 2019), it is crucial to acknowledge the vulnerability of entrepreneurs themselves to the consequences of climate change. The universal impact of climate change and the disproportionate effects on particular groups raise global concerns. Research by Akinbami (2021b) and Ranjan (2015) shed light on this critical aspect. Akinbami (2021b) highlights that individuals involved in agriculture or those reliant on natural resources in rural areas for their livelihoods are among the groups most adversely impacted by climate change. In addition, Ranjan (2015) demonstrates how decreased precipitation can diminish agricultural income and trigger an exodus from the sector. Ranjan (2015) also emphasizes that deciding whether to seize entrepreneurial opportunities in such a context can be challenging and may yield nonoptimal results. These studies caution against viewing entrepreneurship solely as a solution, urging more significant consideration of its potential victims and the need for comprehensive protection measures.

In conclusion, entrepreneurship presents a powerful force for tackling the climate crisis, offering agility, innovation, and resource mobilization potential. However, its effectiveness hinges on supportive policy frameworks, targeted incentives, and recognition of entrepreneurs' dual roles—both as agents of solutions and potential victims of climate change's consequences. By fostering a nurturing environment and acknowledging the multifaceted reality, policymakers and stakeholders can unleash the transformative power of entrepreneurship in building a more sustainable future.

3 | Methodology

This systematic review leverages bibliometric analysis to delve into the academic landscape and chart future research directions within the intersecting realms of entrepreneurship and climate change. A quantitative approach is used to systematically map, evaluate, and track relevant research trends, leveraging Scopus, and VOSviewer software. Bibliometric approaches are particularly valuable in literature reviews as they guide researchers toward the most significant publications and objectively map the study topic (Zupic and Čater 2015).

As observed in various academic publications (Donthu et al. 2021; Guleria and Kaur 2021; Karadayı and Akdemir 2020; Piwowar-Sulej, Krzywonos, and Kwil 2021; Terán-Yépez et al. 2020; Yucel et al. 2022), bibliometric studies offer researchers benefits such as obtaining a comprehensive overview, identifying knowledge gaps, generating new ideas for future research, and positioning contributions to the field (Mukherjee et al. 2022). Consequently, well-executed studies can serve as the foundation for advancing a subject in original and meaningful ways (Donthu et al. 2021; Terán-Yépez et al. 2020).

In the context of our study, bibliometric data about academic research addressing the intersection of entrepreneurship and climate change were examined by employing the three-stage sensemaking approach crafted by Lim and Kumar (2024). This approach encompasses the stages of data scanning, data sensing, and the substantiating of findings. The research diagram of the methodology is given in Figure 1.

3.1 | Aim of the Research

The aim of this research is to understand academic interest in the intersection of climate change and entrepreneurship by examining scholarly publications. As previously discussed, entrepreneurs possess significant potential for addressing climate change-related challenges. Academic papers typically provide an objective assessment of a problem, reflecting the current state of affairs through research. Entrepreneurial activities aimed at addressing climate change-related risks, challenges, and decisions represent a key area of investigation. Scholars increasingly argue that entrepreneurs and their activities should play a central role in mitigating the pace and severity of climate change. However, it remains unclear if these arguments are prevalent in academic literature.

We hypothesize that examining academic interest in entrepreneurship and climate change can drive empirical advancements in entrepreneurship, innovation, and strategy, with the potential for positive societal impact. The primary question of this study is to ascertain whether academics demonstrate interest in entrepreneurial activities focused on addressing climate change and to identify recent trends in scholarly research.

To explore the academic interest in the relationship between "entrepreneurship" and "climate change," this study employs bibliometric analysis. This method allows us to analyze the distribution of publications by year and country, identify leading authors, examine co-occurring keywords, track changes in these keywords over time, and identify main thematic areas using bibliographic coupling. Such an approach provides a comprehensive and holistic view of the subject matter.

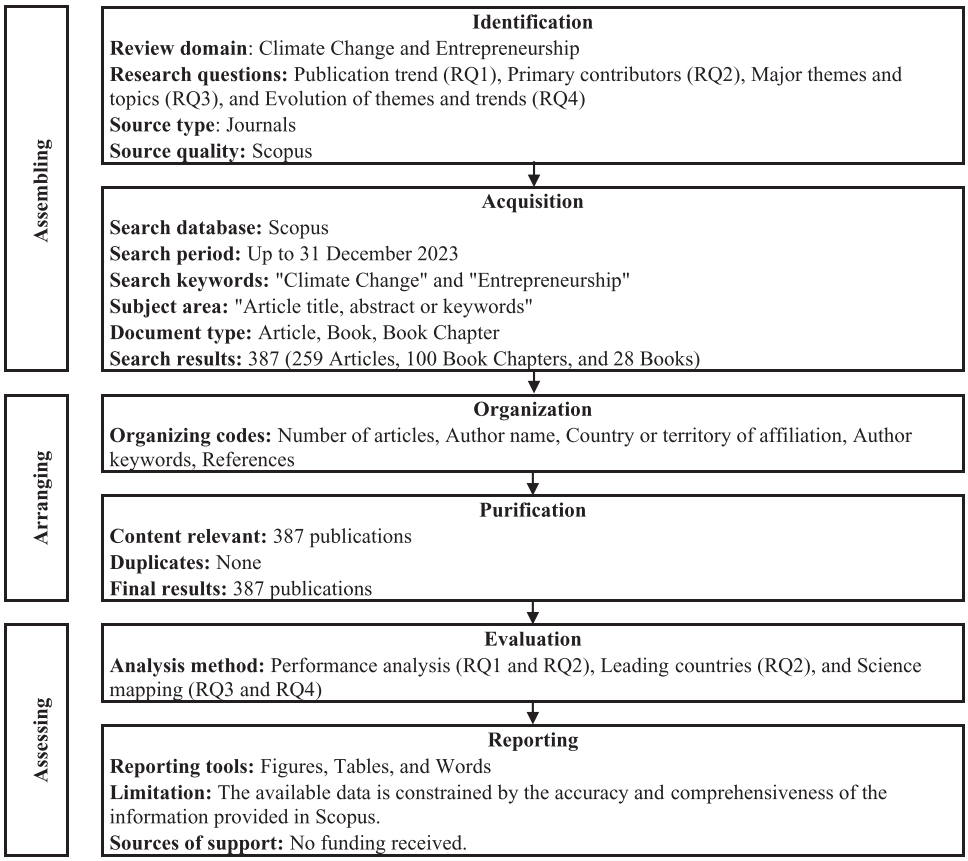


FIGURE 1 | Research diagram.

This study aims to elucidate the nature, trajectory, and intensity of research conducted on entrepreneurial activities related to climate change. Additionally, it may contribute to the establishment of a literature background and research agenda for scholars intending to investigate the intersection of climate change and entrepreneurship. The findings of this study are expected to offer insights or establish a research agenda for researchers (facilitating preliminary exploration in this field), entrepreneurs (guiding them in recognizing opportunities and risks), and policymakers (assisting in the development of future strategies).

3.2 | Data Collection

The Scopus database makes obtaining large volumes of bibliometric data relatively easy. It allows metadata to be analyzed pragmatically with the help of bibliometric software such as Gephi, Leximancer, and VOSviewer. These facilities have recently increased scientific interest in bibliometric analysis (Donthu et al. 2021).

Therefore, Scopus is decided as a suitable database for our research. Table 1 describes the inclusion and exclusion criteria for literature search and analysis. Using this combination eliminates duplicate and irrelevant records (Piwowar-Sulej, Krzywonos, and Kwil 2021).

Twenty-three years spanning from 2001 (the date of first publication) to 2023 are examined in this study. As shown in Table 2, the research is limited to "articles, books, and book chapters," and 387 publications from 84 countries are accessed.

3.3 | Data Analysis

The Scopus database provides information on the number of publications per year, leading authors, the ranking of total publications of countries, and the annual national publication graph. Thus, data on 387 publications indexed in the Scopus database is analyzed using the VOSviewer software (1.6.17 version). Specifically, bibliometric analysis techniques—co-occurrence analysis of keywords and bibliographic coupling analysis of documents—are employed to establish research patterns.

The analysis of the keywords involves the determination of the frequency of occurrence of each keyword in the sampled publications (Van Eck and Waltman 2021). On the other hand, bibliographic coupling, which is based on shared references between publications, facilitates thematic clustering and highlights recent and specialized research, providing valuable insights for scholars to explore diverse themes and stay abreast of current developments (Donthu et al. 2021; Weinberg 1974). Thus, these techniques present researchers with the fields most closely related to the subject and highlight subjects where numerous independent academic studies converge. These analytical methods can offer essential insights, contributing to researchers and readers recognizing connections they may have overlooked and promptly addressing new trending topics.

TABLE 1 | Inclusion and exclusion criteria for literature search and analysis.

Criteria	Reason for inclusion/exclusion
Inclusion criteria	
1. **Published studies from 2001 to the end of 2023**.	1. The first publication on "climate change" and "entrepreneurship" was published in 2001.
2. **Scientifically published studies**.	2. To focus on academic studies and conduct a critical assessment.
3. **Papers addressing the keywords "climate change" and "entrepreneurship."**	3. To ensure a targeted study approach aligned with the desired focus.
4. **Articles, books, and book chapters as document types**.	4. To concentrate on more significant results.
5. **Search conducted within article titles, abstracts, and keywords**.	5. To eliminate potential misleading findings.
6. **Utilizing the Scopus database**.	6. To utilize a globally reputable and extensive database.
7. **Utilizing co-occurrence analysis of keywords and determining the number of publications by country**.	7. To explore trending topics and national interests.
Exclusion criteria	
1. **Excluding document types such as conference papers, reviews, conference reviews, editorials, short surveys, erratum, notes, and retracted publications**.	1. To ensure data quality and consistency for comparative analysis, all papers should undergo peer review.
2. **Not preferring the Web of Science (WoS) database**.	2. Not to achieve the same level of publication breadth as Scopus.
3. **Excluding co-citation and co-authorship analyses**.	3. Exclusion of data outside the study's focus.

TABLE 2 | Search results: Full results and included studies.

Search string	All search hits in Scopus databases	Search hits in "articles, books and book chapters" as document type
Number of publications	457	387 (259 Articles, 100 Book Chapters, and 28 Books)
Number of countries	89	84

However, as citation count data increases cumulatively, new publications have less time to obtain citations. Therefore, citation counts as a measure of impact and tends to favor older publications (Piwowar-Sulej, Krzywonos, and Kwil 2021). Citation numbers are not examined in this study because the scope of the research is different, and the number of citations could be misleading.

4 | Findings

4.1 | Performance Analysis

Within the performance analysis framework, the total number of publications by year and leading author are presented below.

The first performance analysis, the annual number of publications, is limited to the period between 2001 and 2023. As shown in Figure 2, the first study was published in 2001. The increase in the number of publications started in 2006 and continued in a turbulent manner until 2018. After 2018, there were more academic publications on climate change and entrepreneurship each year than the previous year.

The second performance analysis is conducted to identify the top authors in these fields. Among researchers focusing on the intersection of climate change and entrepreneurship, D. Chirambo emerges as the most prolific, with seven publications to his name (Figure 3). E.A.H. Baydoun, C.I. Fernandes, and J.R. Hillman follow closely, each contributing four publications.

Chirambo's research delves into diverse facets of this nexus, including the SDGs, social and policy innovation, and financial inclusion. Notably, a significant portion of his work centers on the African context (Chirambo 2018, 2019, 2021a, 2021b, 2023). He champions entrepreneurship as a potent weapon against climate change and underscores its role in crafting corporate sector policy innovations that facilitate effective SDG implementation.

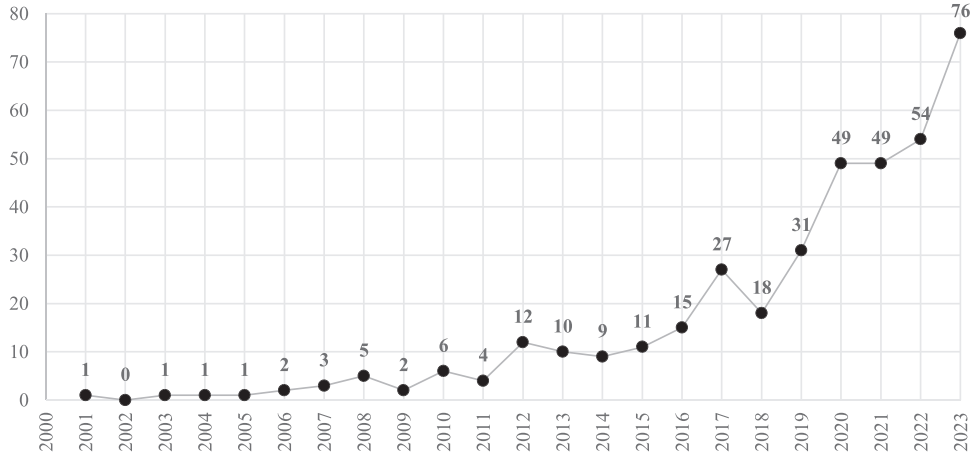


FIGURE 2 | Total number of publications on "Climate Change and Entrepreneurship" by year. *Source:* Scopus. Analyze Search Results. (2024). Scopus-Elsevier. Retrieved January 4, 2024.

TABLE 3 | Leading countries by the number of publications and ratio.

No.	Country/ territory	Number of publications	Publication share (%)	No.	Country/ territory	Number of publications	Publication share (%)
1	United States	69	17.83%	11	Norway	14	3.62%
2	United Kingdom	53	13.70%	12	Finland	13	3.36%
3	Germany	32	8.27%	13	Portugal	13	3.36%
4	The Netherlands	29	7.49%	14	Spain	12	3.10%
5	China	28	7.24%	15	France	11	2.84%
6	India	27	6.98%	16	Italy	11	2.84%
7	Australia	18	4.65%	17	Sweden	11	2.84%
8	Russian Federation	17	4.39%	18	Denmark	8	2.07%
9	Canada	16	4.13%	19	Kyrgyzstan	8	2.07%
10	South Africa	15	3.88%	20	Nigeria	8	2.07%

Source: Scopus. Analyze Search Results (2024). Scopus-Elsevier. Retrieved January 4, 2024.

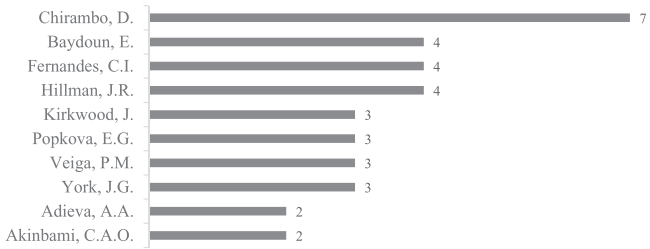


FIGURE 3 | Leading authors by publication number. *Source:* Scopus. Analyze Search Results. (2024). Scopus-Elsevier. Retrieved January 4, 2024.

Identifying the most prolific authors in climate change and entrepreneurship can offer valuable insights for future research directions. However, the landscape within this domain exhibits remarkable collaboration, with over 150 authors contributing to the 387 filtered publications. Even D. Chirambo, with his impressive seven publications, represents only 1.8% (7/387) of the total research output. This highlights the absence of a single dominant voice and underscores the importance of collective knowledge sharing and collaboration within this burgeoning field.

4.2 | Leading Countries by Publication Output

In the bibliometric analysis of academic publications, it is crucial to examine intersections across subjects, considering country/region perspectives. Comparing and critiquing situations provides a comprehensive understanding of how countries address these issues. The number of publications is a reflection of the problem identification and solution search of that geography.

Table 3 presents the leading countries contributing to the domain of climate change and entrepreneurship. The authors based in the United States (US) contribute 69 research articles, which have been cited frequently. The United Kingdom (UK), Germany, and the Netherlands are the next most contributing countries in the

domain of climate change and entrepreneurship, with 53, 32, and 29 articles, respectively.

While developed nations remain the driving force behind field contributions, a surge from developing countries is evident. China and India, for instance, occupy the 5th and 6th place in the number of total publications, with 28 and 27 respectively, a clear testament to this trend. A closer look at Table 4, showcasing annual publication count by country, reveals the Russian Federation and China as the 2023 frontrunners with 14 and 11 publications, respectively. The USA and the UK share third place with India; notably, India also held the runner-up position in 2022.

It is worth noting that while Table 4 initially targeted the top 10 publishing countries between 2001 and 2023, an intriguing discovery emerged. None of these nations tackled the "Climate Change and Entrepreneurship" nexus before 2004. This prompted the inclusion of Thailand and Zimbabwe, pioneers in this arena with their first publications in 2001 and 2003, respectively. This revised table, encompassing 12 countries, offers a more comprehensive picture of the evolving landscape.

4.3 | Science Mapping

Science mapping is a scientific method for revealing an article's conceptual foundation. Co-occurrence analysis of keywords is one of the most popular techniques for identifying a recurring theme (Mishra and Pandey 2023). The resulting keywords are examined according to their average year of publication to expand the analysis provided. We call this a historical view of popular keywords.

4.3.1 | Co-Occurrence Analysis of Keywords

Although the co-occurrence analysis of keywords provides a geographical perspective on the research topic, it is however not sufficient on its own. Identifying what kinds of topics are dealt with—for instance, climate change and entrepreneurship—also plays an important complementary role in understanding the importance of critical points and illuminating priority areas. In the continuation of the study, the common themes in which climate change and entrepreneurship are examined together in academic publications and the orientation of these themes are discussed.

As a result of the co-occurrence analysis of keywords, 1322 terms are defined as raw data. Then, 25 keywords are discovered after the threshold value (minimum number of occurrences of a keyword) is selected as 5.

The 25 keywords are listed in Table 5 with the number of documents. Since the keywords "climate change" and "entrepreneurship" are used as search criteria, it is unsurprising that the biggest tags are "climate change" and "entrepreneurship." Besides these, "sustainability," "innovation," and "Sustainable Development Goals" are, respectively, the most repeated three keywords.

TABLE 4 | Annual publication number by countries.

Country	2023	2022	2021	2020	2019	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001
USA	8	**9**	**6**	**10**	**6**	**5**	4	**3**	**3**	1	**3**	**4**	**1**	**4**		**1**				**1**			
UK	8	4	5	9	3	4	**7**	2	1	**3**	**3**	1	**1**					**2**					
Germany	4	4	5	5	**6**	1	4	1			2												
The Netherlands	3	3	5	4	2	2	3	2	1			1				**1**	**2**						
China	11	4	3	3	1	1	1	1	1			1							**1**				
India	8	5	2	3	3	1	2	1	1					1									
Australia	3	5		2		1	2	1	1	1			**1**			**1**							
Russian Federation	**14**	3																					
Canada	3		2	2		2	1			1	**3**			1			1						
South Africa	4	2	3	2	2	1	1																
Thailand	1											1											**1**
Zimbabwe		1	1																		**1**		

Source: Scopus. Analyze Search Results (2023). Scopus-Elsevier. Retrieved January 4, 2024.
Note: The highest number of publications per year is written in bold.

TABLE 5 | Result of the co-occurrence analysis of keywords.

No.	Keywords	Number of documents by co-occurrence
1	Climate change	89
2	Entrepreneurship	70
3	Sustainability	39
4	Innovation	26
5	Sustainable development goals	19
6	Social entrepreneurship	16
7	Sustainable development	14
8	Policy entrepreneurship	13
9	Circular economy	11
10	Institutional entrepreneurship	11
11	Agriculture	9
12	Digital economy	9
13	Social innovation	9
14	Green entrepreneurship	7
15	Renewable energy	7
16	Resilience	7
17	Sustainable entrepreneurship	7
18	Climate policy	6
19	Environmental entrepreneurship	6
20	Africa	5
21	Covid-19	5
22	Development	5
23	Networks	5
24	Policy innovation	5
25	Social capital	5

The map of the co-occurrence analysis of 25 keywords is presented in Figure 4. It utilizes the "overlay visualization" method, which visualizes keywords based on the average year of publication. The word bubble size indicates the relevant keyword's popularity level according to the values in Table 5. Dark bubbles show old popular keywords, while the lighter color tones of bubbles are closer to the current date.

4.3.2 | A historical look at popular keywords

Understanding how research interests evolve requires examining common themes within specific periods. Figure 5 serves as a valuable guide, highlighting the thematic transformation of key concepts from 2014 to 2023. Given that the earliest average year of publication in our dataset is 2014, the analysis of keyword popularity commences from this point.

We can ascertain the average year of publication associated with each keyword by employing the historical visualization (overlay visualization) functionality within VOSviewer software. An in-depth exploration of these frequently used terms sheds light on historical trends and their evolution. By delving into the historical analysis of keyword relationships, we observe that "Institutional Entrepreneurship" emerged as the dominant popular concept in 2014, while "Digital Economy" took the mantle in 2023. This shift illustrates the dynamic nature of research priorities within this field.

In analyzing subsequent transformations of academic interest, the keyword "Social," emblematic of society as both the influencer and the affected by climate change, becomes apparent. Then, sustainability-oriented themes such as sustainable development, sustainability, sustainable entrepreneurship, and sustainable development goals, which are among the magic keywords that will save future societies, emerge.

4.3.3 | Clusters/Themes in Climate Change and Entrepreneurship Research via Bibliographic Coupling

Bibliographic coupling is a method used in science mapping, premised on the idea that two publications with overlapping references are likely to have similar content (Weinberg 1974). Through bibliographic coupling, thematic clusters are established using shared citations, enabling recent, and specialized publications to be highlighted. This makes bibliographic coupling particularly beneficial for business scholars seeking to explore

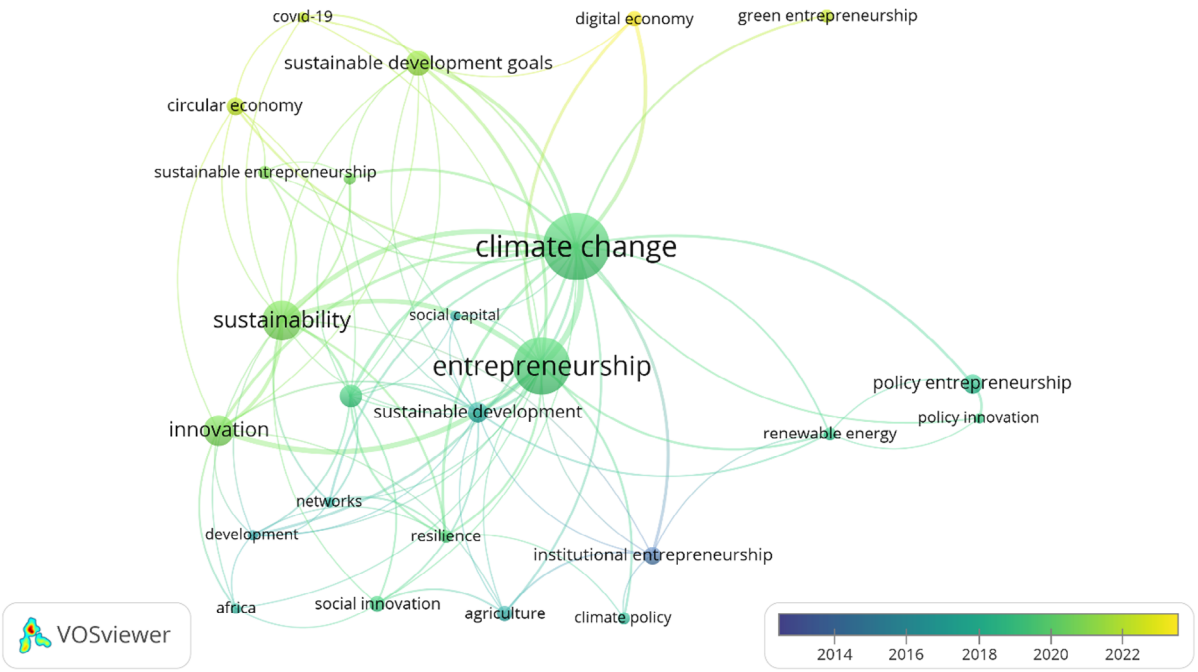


FIGURE 4 | Map of the co-occurrence analysis of keywords.

2014	Institutional Entrepreneurship						
2015							
2016	Development	Social Capital					
2017	Network	Africa	Agriculture	Sustainable Development			
2018		Climate Policy	Renewable Energy	Policy Entrepreneurship			
2019		Policy Innovation	Resilience	Social Innovation	Social Entrepreneurship		
2020			Sustainability	Innovation	Environmental Entrepreneurship	Sustainable Entrepreneurship	
2021				Sustainable Development Goals	Green Entrepreneurship	Circular Economy	Covid-19
2022							
2023							Digital Economy

FIGURE 5 | Popular keywords by average year of publication.

a wide range of themes and stay updated on the latest developments. Consequently, the analysis offers an insight into the current state of the research field (Donthu et al. 2021).

The process of linking studies within the body of research on climate change and entrepreneurship through bibliographic coupling has led to the discovery of 17 distinct clusters or themes, with each cluster containing a group of related articles (as illustrated in Figure 6). Table 6 showcases the top four studies within each cluster or theme.

Cluster/Theme #1 is related to *the role of policy entrepreneurship in driving climate change governance and action*. Policy entrepreneurs are proactive actors who collaborate with decision-makers to promote significant policy changes and shape policies. Consequently, it is anticipated that policy entrepreneurs will play a vital role in future efforts to combat climate change (Mintrom and Luetjens 2017). Carter and Jacobs (2014) focus on the role of policy entrepreneurs in driving major changes in climate policies in the United Kingdom. Similarly, Mintrom and Luetjens (2017) examine the activities of policy entrepreneurs in problem framing and promoting large-scale behavioral changes related to climate change and what they do to address the issue. Acuto (2013) and Toly (2008) address environmental issues such as climate change from a municipal perspective and emphasize the crucial role of municipalities in effectively responding to significant challenges such as climate change or sustainability. Both studies highlight the potential for entrepreneurs to facilitate the articulation

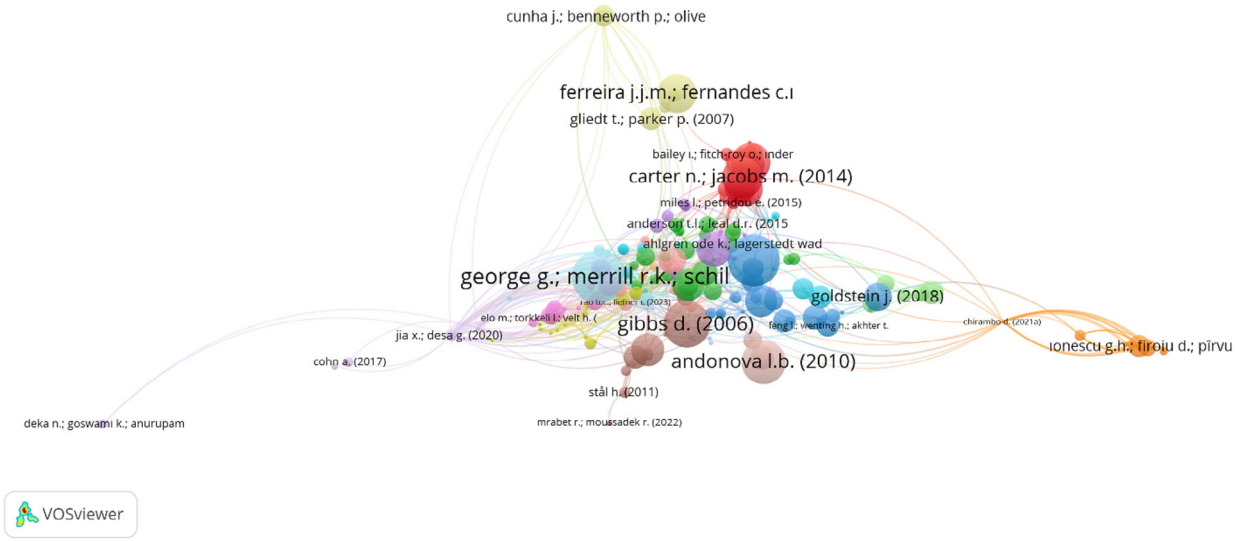


FIGURE 6 | Nomological network of clusters in climate change and entrepreneurship.

(spread, adoption, interpretation, and operationalization) of new and disruptive policy changes in combating climate change.

Cluster/Theme #2 is about *the intersection of entrepreneurship, innovation, and sustainability across climate change*. The main common theme of Cluster 2 is the exploration of entrepreneurship, innovation, and sustainability in various contexts. Each article investigates how entrepreneurial activities, innovative approaches, and strategic orientations can address complex societal and environmental challenges such as climate change. Whether it's Cleantech startups collaborating with governments (Doblinger, Surana, and Anadon 2019), the development of sustainable tourism (Furunes and Mykletun 2012; Ramaano 2023), the need for problem-oriented innovation systems (Ghazinoory et al. 2020), or the emergence of green entrepreneurship (Haldar 2019; Zhou et al. 2021), these articles collectively focus on finding solutions to pressing global issues such as climate change. They emphasize the role of different actors, including governments, universities, entrepreneurs, and communities, in driving positive change and fostering sustainable development (Owen and Vedanthachari 2022).

Cluster/Theme #3 explores *the importance of entrepreneurship for sustainability*, particularly in addressing the challenges posed by climate change and promoting responsible resource management. This theme is evident across several articles. For instance, Apfel and Herbes (2021) and Süsser, Döring, and Ratter (2017) delve into the contribution of entrepreneurs in advancing the transition toward renewable energy sources. Kangogo, Dentoni, and Bijman (2021) shed light on how farmer entrepreneurial orientation influences the adoption of climate-smart agriculture practices. Kuckertz, Berger, and Brändle (2020) discuss the potential of entrepreneurship in driving the shift toward a bio-based economy. Moreover, Wijen and Ansari (2007) and Ye et al. (2020) examine factors like green entrepreneurship and institutional entrepreneurship that play key roles in shaping entrepreneurial decisions toward sustainability. Collectively, these studies underscore the significance of entrepreneurial attitudes, actions, and collaborations across various sectors such as energy, agriculture, infrastructure, and clean technology, as well as in diverse geographical contexts spanning Europe, Africa, and Asia.

The common main idea of the articles in *Cluster/Theme #4* is the pivotal role of *entrepreneurship in driving sustainable development and addressing global challenges*. Across various contexts and perspectives, these articles highlight the transformative potential of entrepreneurship to catalyze positive change and contribute to the achievement of sustainability goals. Tiemann, Fichter, and Geier (2018) emphasize the role of universities in fostering sustainable entrepreneurship, while Ansah and Sorooshian (2019) discuss the private sector's contribution to climate change adaptation and mitigation efforts. Similarly, Canestrino et al. (2023) explore the emergence of humane entrepreneurial ecosystems and the importance of cultural context in shaping entrepreneurial practices. Furthermore, Braukmann, Koch, and Bartsch (2023) underscore the significance of youth entrepreneurship education in driving a "great transformation" toward sustainability. Moreover, Stephenson and Furman (2024) advocate for climate-just entrepreneurship as a means to integrate proactive climate action with gender equality measures. These articles collectively illustrate the pivotal role of entrepreneurship in addressing complex global challenges and advancing sustainability agendas.

Cluster/Theme #5 is related to *the pivotal role of entrepreneurship and sustainable business practices within SMEs*. Each study delves into how small businesses and SMEs navigate environmental challenges, societal expectations, and economic pressures while striving for sustainability and competitive advantage. Sloan, Legrand, and Chen (2013) emphasize the importance for SMEs in the hospitality industry to adopt sustainable operations to meet stakeholder expectations. Muhammad Auwal et al. (2020) specifically investigate the influence of external pressures on the entrepreneurship performance of SMEs in the herbal industry, highlighting the need for sustainable practices to gain a competitive edge. Amaeshi, Nnodim, and Onyeka (2013) discuss the relevance of corporate social responsibility for SMEs, framing it as a means of addressing societal and environmental concerns while enhancing business reputation. Dressler (2023) explores how environmentalism guides strategic orientation in

TABLE 6 | Major themes in climate change and entrepreneurship research.

Article	Authors	Source	Citations
Cluster/Theme #1: The role of policy entrepreneurship in driving climate change governance and action			
Explaining radical policy change: The case of climate change and energy policy under the British labor government 2006–10	Carter and Jacobs (2014)	Public Administration	132
Transnational municipal networks in climate politics: From global governance to global politics	Toly (2008)	Globalizations	121
Policy entrepreneurs and problem framing: The case of climate change	Mintrom and Luetjens (2017)	Environment and Planning C: Politics and Space	103
City leadership in global governance	Acuto (2013)	Global Governance	74
Cluster/Theme #2: The intersection of entrepreneurship, innovation, and sustainability across climate change			
Governments as partners: The role of alliances in US cleantech startup innovation	Doblinger, Surana, and Anadon (2019)	Research Policy	84
Frozen adventure at risk? A 7-year follow-up study of Norwegian glacier tourism	Furunes and Mykletun (2012)	Scandinavian Journal of Hospitality and Tourism	49
Why do we need "Problem-oriented Innovation System (PIS)" for solving macro-level societal problems?	Ghazinoory et al. (2020)	Technological Forecasting and Social Change	31
Rise up: Understanding youth social entrepreneurs and their ecosystems	Bublitz et al. (2021)	Journal of Public Policy and Marketing	25
Cluster/Theme #3: Entrepreneurship for sustainability			
Overcoming inaction through collective institutional entrepreneurship: Insights from regime theory	Wijen and Ansari (2007)	Organization Studies	219
Harvesting energy: Place and local entrepreneurship in community-based renewable energy transition	Süsser, Döring, and Ratter (2017)	Energy Policy	83
Planetary improvement: Cleantech entrepreneurship and the contradictions of green capitalism (Book)	Goldstein (2018)	Planetary Improvement: Cleantech Entrepreneurship and the Contradictions of Green Capitalism	62
Adoption of climate-smart agriculture among smallholder farmers: Does farmer entrepreneurship matter?	Kangogo, Dentoni, and Bijman (2021)	Land Use Policy	46
Cluster/Theme #4: Entrepreneurship in driving sustainable development and addressing global challenges			
University support systems for sustainable entrepreneurship: Insights from explorative case studies	Tiemann, Fichter, and Geier (2018)	International Journal of Entrepreneurial Venturing	13
Regenerative organizations: Introduction to the special issue	Muñoz and Branzei (2021)	Organization and Environment	13
Green economy: Private sectors' response to climate change	Ansah and Sorooshian (2019)	Environmental Quality Management	10
Toward the emergence of "humane" entrepreneurial ecosystems. Evidence from different cultural contexts	Canestrino et al. (2023)	Journal of Intellectual Capital	6
Cluster/Theme #5: Entrepreneurship and sustainable business practices within SMEs			
Sustainability in the hospitality industry 2nd ed: Principles of sustainable operations (Book)	Sloan, Legrand, and Chen (2013)	Sustainability in the Hospitality Industry 2nd Ed: Principles of Sustainable Operations	100
External pressure influence on entrepreneurship performance of SMEs: A case study of Malaysian herbal industry	Muhammad Auwal et al. (2020)	Journal of Small Business and Entrepreneurship	30

(Continues)

TABLE 6 | (Continued)

Article	Authors	Source	Citations
Corporate social responsibility entrepreneurship and innovation (Book)	Amaeshi, Nnodim, and Onyeka (2013)	Corporate Social Responsibility Entrepreneurship and Innovation	16
Orchestrating entrepreneurial ecosystems in circular economy: The new paradigm of sustainable competitiveness.	Castro Oliveira et al. (2022)	Management of Environmental Quality: An International Journal	14
Cluster/Theme #6: Entrepreneurship for the Circular Economy and Sustainable Practices			
Building competitive advantage with sustainable products—A case study perspective of stakeholders	Kahupi et al. (2021)	Journal of Cleaner Production	41
A tool for collaborative circular proposition design	Brown et al. (2021)	Journal of Cleaner Production	34
Climate change and entrepreneurship	Embry, Jones, and York (2019)	Handbook of Inclusive Innovation: The Role of Organizations, Markets and Communities in Social Innovation	9
Climate-entrepreneurship in response to climate change: Lessons from the Korean emissions trading scheme (ETS)	Lee and Ahn (2019)	International Journal of Climate Change Strategies and Management	9
Cluster/Theme #7: Entrepreneurship for Sustainable Development in Various Geographic Locations			
The potential for innovation and entrepreneurship in EU countries in the context of sustainable development	Ionescu et al. (2020)	Sustainability	36
Enhancing climate change resilience through microfinance: Redefining the climate finance paradigm to promote inclusive growth in Africa	Chirambo (2017)	Journal of Developing Societies	22
Advancing African agency in the new 2030 transformative development agenda	Besada et al. (2016)	African Geographical Review	9
Integrating microfinance, climate finance and climate change adaptation: A Sub-Saharan Africa perspective	Chirambo (2016)	Climate Change Management	5
Cluster/Theme #8: Sustainable Entrepreneurship and Institutional Entrepreneurship for Climate Change Mitigation and Adaptation			
Sustainability entrepreneurs, ecopreneurs and the development of a sustainable economy	Gibbs (2006)	Greener Management International	177
Upscaling of business model experiments in off-grid PV solar energy in India	Jolly, Raven, and Romijn (2012)	Sustainability Science	87
The inclusion of aviation in the EU emissions trading scheme: Temporal conditions for institutional entrepreneurship	Buhr (2012)	Organization Studies	43
Entrepreneurship in nature-based tourism under a changing climate	Tervo-Kankare (2019)	Current Issues in Tourism	21
Cluster/Theme #9: Innovation in entrepreneurship for combating climate change			
The interplay of corporate entrepreneurship, environmental orientation, and performance in clean-tech firms—A double-edged sword	Niemann, Dickel, and Eckardt (2020)	Business Strategy and the Environment	34
Towards designing society 5.0 solutions: The new Quintuple Helix—Design Thinking approach to technology	Bartoloni et al. (2022)	Technovation	30

(Continues)

TABLE 6 | (Continued)

Article	Authors	Source	Citations
Born to be sustainable: How to combine strategic disruption, open innovation, and process digitization to create a sustainable business	Allal-Chérif, Climent, and Berenguer (2023)	Journal of Business Research	26
Configurations of sustainable development goals that promote sustainable entrepreneurship over time	Moya-Clemente, Ribes-Giner, and Pantoja-Díaz (2020)	Sustainable Development	20
Cluster/Theme #10: Entrepreneurship in Developing New Solutions and Business Models to Climate Change.			
Encouraging sustainable entrepreneurship in climate-threatened communities: A Samoan case study	Gray et al. (2014)	Entrepreneurship and Regional Development	62
How fear of looming megacatastrophes alters entrepreneurial activity rates through psychological distance	Bendell, Sullivan, and Ornstein (2020)	Academy of Management Perspectives	16
Permaculture in Portugal: Social-ecological inventory of a re-ruralizing grassroots movement	Oliveira and Penha-Lopes (2020)	European Countryside	11
National systems of entrepreneurship: Goals of sustainability	Raposo, Fernandes, and Veiga 2020	Journal of Entrepreneurship and Public Policy	9
Cluster/Theme #11: Green Entrepreneurship to Environmental Challenges and Climate Change.			
The influence of legitimacy on a proactive green orientation and green performance: A study based on transitional economy scenarios in China	Ge et al. (2016)	Sustainability	44
Climate change policy and entrepreneurial opportunities	Crecente, Sarabia, and del Val (2021)	Technological Forecasting and Social Change	26
A process-oriented framework of competencies for sustainability entrepreneurship	Foucrier and Wiek (2019)	Sustainability	24
How does the appeal of environmental values influence sustainable entrepreneurial intention?		International Journal of Environmental Research and Public Health	22
Cluster/Theme #12: Entrepreneurial's environmental impacts and sustainable development goals			
Entrepreneurial food ecosystem: Strategic driver to boost resilience and sustainability	De Bernardi et al. (2020)	Innovation in Food Ecosystems: Entrepreneurship for a Sustainable Future	2
An investigation of climate change within the framework of a Schumpeterian economic growth model	Sahin and Ayyildiz (2022)	Business and Policy Solutions to Climate Change: From Mitigation to Adaptation	1
Beyond goal hybridity: How multilevel actor networks can scale climate impact	Sunny (2022)	In World Scientific Encyclopedia Of Business Sustainability, Ethics And Entrepreneurship	0
Science communicators as commercial and social entrepreneurs	Walker (2014)	In Communicating Science to the Public: Opportunities and Challenges for the Asia-Pacific Region. Dordrecht: Springer Netherlands.	0
Cluster/Theme #13: Social entrepreneurship and social innovation			
Technology transfer, climate change mitigation, and environmental patent impact on sustainability and economic growth: A comparison of European countries	Ferreira, Fernandes, and Ferreira (2020).	Technological Forecasting and Social Change	124

(Continues)

TABLE 6 | (Continued)

Article	Authors	Source	Citations
Green community entrepreneurship: creative destruction in the social economy	Gliedt and Parker (2007)	International Journal of Social Economics	40
Social entrepreneurship and social innovation: A conceptual distinction	Cunha, Benneworth, and Oliveira (2015)	In Handbook of Research on Global Competitive Advantage Through Innovation and Entrepreneurship. IGI Global.	35
Challenges of rising inequalities and the quest for inclusive and sustainable development.	Brundenius (2017)	Universities, Inclusive Development and Social Innovation: An International Perspective,	11
Cluster/Theme #14: Ecosystem stakeholders, ecological agriculture and green entrepreneurship			
Social entrepreneurship and impact investment in rural–urban transformation: An orientation to systemic social innovation and symposium findings.	Jia and Desa (2022)	Agriculture and Human Values	9
Leveraging climate regulation by ecosystems for agriculture to promote ecosystem stewardship	Cohn (2017)	Tropical Conservation Science	8
What will drive the small tea growers towards environment-friendly cultivation? Implications from the tea sector in Assam, India	Deka, Goswami, and Anurupam (2022)	Climate and Development	6
Community initiatives and local networks among K'ho Cil smallholder coffee farmers in the central highlands of Vietnam: A case study	Truong (2020)	Journal of Asian and African Studies	5
Cluster/Theme #15: Policy entrepreneurship for mitigating ecological risks and climate change			
Digital sustainability and entrepreneurship: How digital innovations are helping tackle climate change and sustainable development.	George, Merrill, and Schillebeeckx (2021)	Entrepreneurship theory and practice	231
The emergence of biosphere entrepreneurship: Are social and business entrepreneurship obsolete?	Frederick (2018)	International Journal of Entrepreneurship and Small Business	14
From 'Green Laggard' to regional leader: Explaining the recent development of environmental policy in Chile.	Madariaga (2019)	Bulletin of Latin American Research	9
Social entrepreneurship intentions among business students in Oman.	Magd, Khan, and Bhuyan (2022)	In International Perspectives on Value Creation and Sustainability Through Social Entrepreneurship. IGI Global.	5
Cluster/Theme #16: Community-based adaptive entrepreneurship and climatepreneurship			
Shaping conditions for entrepreneurship in climate change adaptation: A case study of an emerging governance arrangement in the Netherlands	de Block, Feindt, and van Slobbe (2019)	Ecology and Society	5
Heterogenising forestry value production—Drivers and barriers of entering the non-wood forest products sector	Muttilainen and Vilko (2022)	Current Research in Environmental Sustainability	5
'Community-based adaptive entrepreneurship' addressing climate and ecosystem changes: Evidence from a riparian area in Bangladesh	Shahidullah (2023)	Climate Risk Management	0
Climatepreneurship: Adaptation strategy for climate change impacts on rural women entrepreneurship development in Nigeria	Akinbami (2021a)	African Handbook of Climate Change Adaptation: With 610 Figures and 361 Tables	0

(Continues)

TABLE 6 | (Continued)

Article	Authors	Source	Citations
Cluster/Theme #17: Networks based on green entrepreneurship			
Public-private partnerships for the earth: Politics and patterns of hybrid authority in the multilateral system	Andonova (2010)	Global Environmental Politics	157
Novel multisector networks and entrepreneurship in urban climate governance	Schroeder, Burch, and Rayner (2013)	Environment and Planning C: Government and Policy	44
Novel multisector networks and entrepreneurship: The role of small businesses in the multilevel governance of climate change.	Burch et al. (2013)	Environment and Planning C: Government and Policy	25
Green entrepreneurship: A disruptive mitigation strategy for climate change	Potluri and Phani (2022)	In Handbook of Climate Change Mitigation and Adaptation. Cham: Springer International Publishing.	1

small enterprises, underscoring the significance of sustainability-oriented practices for SMEs' performance. These studies collectively emphasize the critical role of small businesses and SMEs in driving sustainability initiatives, innovation, and economic development while navigating the complexities of environmental and social challenges.

The common main idea of *Cluster/Theme #6* is the integration of *entrepreneurship for the circular economy and sustainable practices*. Brown et al. (2021) discuss how entrepreneurship drives the adoption of circular business models, fostering resource efficiency, and waste reduction. They also highlight how entrepreneurs collaborate with partners to identify opportunities and create value within circular business ecosystems. Kahupi et al. (2021) emphasize the potential for building a competitive advantage with sustainable products, stressing the role of entrepreneurs in identifying and capitalizing on market demand for eco-friendly solutions. Similarly, Alan and Köker (2023) analyze agricultural waste recycling as a profitable business opportunity within the circular economy, showcasing how entrepreneurs can leverage innovative technologies and business practices to address environmental challenges while creating economic value. Lee and Ahn (2019) explore climate entrepreneurship and its impact on corporate responses to climate change, emphasizing the proactive role of businesses in implementing carbon management practices. Finally, Santolin et al. (2023) investigate circular economy enablers for SMEs in the post-COVID-19 era, highlighting the importance of digital technologies and circular entrepreneurship in advancing sustainable development. Overall, entrepreneurs play a crucial role in identifying opportunities, developing innovative solutions, and navigating regulatory landscapes to promote sustainable business practices and advance the transition toward a circular economy.

Cluster/Theme #7 revolves around *entrepreneurship for sustainable development in various geographic locations*, such as the European Union and Africa. These articles collectively emphasize the critical role of entrepreneurship as a driver of innovative solutions to address the challenges posed by climate change while fostering sustainable development. For example, Ionescu et al. (2020) underscore how innovation and entrepreneurship are essential for overcoming global societal challenges, including climate change, and achieving sustainable development in EU countries. Similarly, Chirambo (2016, 2017, 2021b) explores how microfinance can be utilized through entrepreneurship for climate change adaptation and inclusive growth in Africa, thereby contributing to the SDGs. Additionally, Besada et al. (2016) discuss advancing African agency through public entrepreneurship to align with the SDGs and address climate change challenges. Lastly, Lichtenthaler (2023) argues that businesses need to move beyond merely avoiding harm and embrace positive sustainability to create a net positive impact and contribute to sustainable development. Collectively, these articles demonstrate the crucial role of entrepreneurship in driving climate change resilience and sustainable development across diverse geographic locations, highlighting the need for innovative entrepreneurial solutions to tackle pressing global challenges.

Cluster/Theme #8 is about the exploration of *sustainable entrepreneurship and institutional entrepreneurship for climate change mitigation and adaptation*. Gibbs (2006) discusses the role of sustainability entrepreneurs, or ecopreneurs, in driving a shift toward a sustainable economy by integrating sustainable development into business practices. Tervo-Kankare (2019) investigates the values and attitudes of nature-based tourism entrepreneurs in relation to climate change adaptation, highlighting the role of sustainable entrepreneurship in fostering resilience within the tourism industry. Buhr (2012) examines the temporal conditions for institutional entrepreneurship in climate policy, focusing on the inclusion of aviation in emissions trading schemes. Duijn and van Buuren (2017) explore the absence of institutional entrepreneurship in climate adaptation policy, emphasizing the challenges and opportunities for entrepreneurial actions in reshaping institutional practices to address climate-related risks. Stål, Bonnedahl, and Eriksson (2014) examine institutional entrepreneurship in promoting low-carbon industrial practices in the agri-food sector. Collectively, these articles highlight the importance of sustainable entrepreneurs and institutional entrepreneurship in driving innovation, shaping policy, and fostering adaptation in response to climate change challenges.

The common main theme of *Cluster #9* is *the innovation in entrepreneurship for combating climate change*. Each article

explores various facets of how innovation, particularly in the realms of technology, business models, and sustainability practices, is essential for addressing the challenges posed by climate change while also fostering entrepreneurial activities. Niemann, Dickel, and Eckardt (2020) discuss how established companies can leverage entrepreneurship internally to develop clean technologies. Bartoloni et al. (2022) discuss the integration of Industry 4.0 technologies within Society 5.0, emphasizing human-centric innovation to tackle societal challenges like climate change. Allal-Chérif, Climent, and Berenguer (2023) examine how sustainable entrepreneurship, characterized by strategic disruption and open innovation, can lead to environmentally conscious business practices. Moya-Clemente, Ribes-Giner, and Pantoja-Díaz (2020) touch on the role of collaboration and new approaches to design and research in fostering innovation for a sustainable future, emphasizing the role of environmental factors like clean water and affordable clean energy. These articles collectively emphasize the crucial role of innovation-driven entrepreneurship in driving sustainability efforts amidst the challenges posed by climate change.

Cluster/theme #10 centers on *entrepreneurship in developing new solutions and business models to climate change*. Gray et al. (2014) emphasize the importance of sustainable entrepreneurship in climate-threatened communities, highlighting the role of organizations in facilitating sustainable enterprises. Several articles explore specific examples of entrepreneurs creating these solutions, such as permaculture design for sustainable land management (Oliveira and Penha-Lopes 2020) or businesses that can help rural communities adapt to drought (Casey et al. 2022). Another article explores the impact of national systems of entrepreneurship on the development of a circular economy, a strategy for reducing waste (Fernandes, Veiga, and Ramadani 2023). Even studies that focus on broader challenges, like the fear of climate change, acknowledge the potential for entrepreneurs to innovate and adapt (Bendell, Sullivan, and Ornstein 2020). Collectively, these articles underscore the pivotal role of entrepreneurs in developing innovative solutions and business models to tackle climate change and promote sustainability.

Cluster/theme #11 is related to the relationship between *green entrepreneurship and environmental-cum-climate challenges*. Ge et al. (2016) emphasize the importance of green entrepreneurship in addressing environmental pollution, climate change, and resource scarcity, highlighting its role in simultaneously addressing economic performance, environmental impact, and social responsibility. Similarly, Crecente, Sarabia, and del Val (2021) underscore the significance of climate change policies, such as the SDGs, in inspiring various forms of entrepreneurship that combine value creation with conservation and social protection. Foucrier and Wiek (2019) further emphasize the role of sustainability entrepreneurship in responding to prevalent challenges like climate change and economic inequalities. Additionally, Yasir et al. (2023) highlight the shift toward green entrepreneurship as a response to discussions emphasizing ecological sustainability, emphasizing its crucial role in predicting economic growth amidst climate change and environmental degradation. Overall, these articles collectively underscore the importance of green entrepreneurship in addressing climate change and fostering sustainability in various economic sectors.

Cluster/Theme #12 focuses on *the entrepreneurial's environmental impacts and sustainable development goals*. De Bernardi et al. (2020) underscore the challenges posed by climate change, population growth, and resource depletion, emphasizing the necessity of research and innovation in promoting sustainability within the food ecosystem. Şahin and Ayyıldız (2022) delve into the intricate relationship between climate change, economic growth, and sustainability, examining variables such as CO_2 emissions, fixed capital investments, government expenditures, real savings, and patent applications. Sunny (2022) explores the role of organizational actors as environmental entrepreneurs, analyzing the environmental consequences of current structural actions, the varying outcomes observed across different groups of actors at multiple levels, and the need for a multilevel network model capable of coordinating the diverse structural constraints. Additionally, Walker (2014) elucidates the driving forces behind social entrepreneurship, which serves to address societal challenges and mitigate the impacts of climate change.

Cluster/Theme #13 explores *social entrepreneurship and social innovation* aimed at achieving social and ecological economic objectives. Ferreira, Fernandes, and Ferreira (2020) highlight the influence of geographical context on technology transfer and patents, particularly in areas such as environmental water-related adaptation technology and climate change mitigation patents, underscoring how innovation and entrepreneurial actions can shape a country's sustainability performance. Gliedt and Parker (2007) emphasize the importance of green community entrepreneurship, which relies on external social capital network flows, internal human capital stocks, and strategic partnerships. They argue for policy support and the integration of social and ecological economic objectives to bolster green community entrepreneurship. Cunha, Benneworth, and Oliveira (2015) discuss the role of social innovation and social entrepreneurship in addressing emerging problems affecting large populations, such as climate change, chronic diseases, income inequality, unemployment, aging populations, and urbanization. Lastly, Brundenius (2017) advocates for the differentiation of social innovation and social entrepreneurship from traditional innovation approaches, emphasizing their broader impact beyond economic and social progress.

Cluster/Theme #14 delves into *ecosystem stakeholders, ecological agriculture, and green entrepreneurship*. Jia and Desa (2022) underscore the significance of social entrepreneurship and innovative finance, as well as the interactions among ecosystem stakeholders. Cohn (2017) emphasizes the need for climate regulation by ecosystem stakeholders in tropical land use decision-making and highlights production-protection synergies relevant to critical actors. Deka, Goswami, and Anurupam (2022) discuss how environment-friendly organic cultivation fosters entrepreneurship, particularly in small-scale tea processing, serving as a key driver for empowered sustainability in developing countries. Truong (2020) articulates that coffee farmers, acting as partners within the network, shield themselves from the impacts of climate change through regulatory measures and foster regenerated local initiatives within the global coffee commodity chain.

Cluster/Theme #15 focuses on *policy entrepreneurship for mitigating ecological risks and climate change*. George, Merrill, and Schillebeeckx (2021) discuss how digital technologies can

contribute to combating climate change and fostering digital sustainable development in entrepreneurship, business models, and ecosystems. Frederick (2018) and Magd, Khan, and Bhuyan (2022) define biosphere entrepreneurship as a means to add value to the Earth, mitigating ecological risks and climate change through entrepreneurial education. Madariaga (2019) underscores the importance of international influences, institutional legacies, opportunities promoted by environmental movements, policy entrepreneurship, and business power in advancing green entrepreneurship.

Cluster/Theme #16 explores *community-based adaptive entrepreneurship and climatepreneurship*. de Block, Feindt, and van Slobbe (2019) highlight the vital role of decision-makers in determining the conditions for entrepreneurial success in the face of climate change. Muttilainen and Vilko (2022) discuss how climate change threatens forest owners and identify drivers and barriers for this heterogeneous group entering the non-wood forest products sector. Shahidullah (2023) discuss community-based adaptive entrepreneurship as an entrepreneurial model in response to climate and ecosystem changes. Akinbami (2021a) emphasizes the importance of promoting entrepreneurship among rural women as part of the climate change adaptation process.

Cluster/Theme #17 is about *networks based on green entrepreneurship*. Andonova (2010) highlights the importance of establishing public-private partnerships for environmental governance, community-based biodiversity management, and climate change-related technology. Potluri and Phani (2022) argue that green entrepreneurship should be promoted as part of a community-based networking strategy to mitigate climate change. Burch et al. (2013) and Schroeder, Burch, and Rayner (2013) find that novel multisector networks and entrepreneurship can succeed when linked at multiple levels.

5 | Discussion

Children in the 21st century inhabit a distinct era marked by unprecedented challenges. The deleterious consequences of human activity on the planet have reached an unparalleled magnitude throughout previous epochs. Climate change, in particular, manifests itself through a myriad of destructive phenomena, including extreme weather events, prolonged droughts, natural disasters, and the alarming loss of biodiversity. Regrettably, humanity has not garnered commendable results in climate change mitigation (WEF 2023). However, these results do not imply that awareness of this issue is not increasing. In academic literature, there is a growing interest in the roles that entrepreneurial activities will assume in mitigating and adapting to climate change, and there is a high confidence in political, social, and environmental entrepreneurial initiatives in this regard.

5.1 | Theoretical Implications

This study enhances current knowledge by investigating researchers' attitudes toward the intersections of climate change and entrepreneurship. Evaluating crucial economic factors like entrepreneurial activities becomes paramount amid escalating climate change crises. Deliberations on their extent and impact are vital for understanding the intricate relationship between environmental challenges and economic dynamics.

5.1.1 | Correlating Publication Trends With Climate Change-Based Natural Disasters in Academic Research

In 2003, Europe experienced scorching temperatures that resulted in substantial loss of life, particularly among the elderly. The following year, the US confronted an intense Atlantic hurricane season in 2004, causing a record-breaking $42 billion in damages. Hurricane Katrina surpassed this record in 2005, inflicting over $100 billion in damages (Van Aalst 2006). Subsequent catastrophic events, including Hurricane Narcissus in Myanmar (2008), the heatwave in Russia (2010), and the flood disaster in Thailand (2011), claimed thousands of lives and caused billions of dollars in damages. Moreover, an analysis conducted by Save the Children (2023) reveals that in 2023 alone, 12,000 people lost their lives due to climate disasters. These distressing events underscore the profound human toll and economic ramifications of climate-related disasters.

The prevalence of global calamities has intensified international attention on climate change, prompting an examination of the interconnection between entrepreneurship and climate change in academic publications. Entrepreneurial activities, akin to all businesses, hinge on supply-demand dynamics. Consequently, each crisis and disaster demands solutions or business opportunities. These crises and disasters not only elevate the demand for solutions but also foster an increased supply of startups. In tandem with these developments, addressing the intersection of entrepreneurship and climate change may elucidate this dynamic supply and demand equilibrium. There is increasing academic and policy debate seeking economic solutions from entrepreneurs to overcome these challenges. Consequently, increasing academic publications is expected to parallel the growing discourse.

The findings of this study substantiate a discernible surge in academic publications coinciding with such disasters, indicating a notable uptrend in scholarly output since 2006. Importantly, this upward trajectory has persisted unabated since 2018.

5.1.2 | Interpretation of the Link Between Publication Number and Country Contribution

Upon scrutinizing the research findings, it becomes apparent that the emphasis on climate change and entrepreneurship correlates with the level of economic development. Developed countries, having resolved their core economic and political challenges, have spearheaded initiatives and policies addressing climate change, thereby capturing the attention of developing nations. Paradoxically, these developed countries have also historically made significant contributions to carbon emissions due to their extensive industrial activities (World Resources Institute 2023). Furthermore, developed countries offer greater incentives for publication and a more conducive academic research environment compared to their developing counterparts, attracting researchers globally (Galvez et al. 2000). It is expected that in

developed countries, which are centers of attraction for science, there will be more academic studies and a cumulative higher number of publications over the years.

This phenomenon aligns with the publication data presented in Tables 3 and 4, reinforcing the literature's predictions. The US (69 publications), the UK (53), and Germany (32) lead in cumulative publications, collectively constituting around 40% (154 out of 387) of all publications across 84 countries involved in the research domain. Notably, 14 of the top 20 countries in terms of publications, as listed in Table 3, are classified as developed countries by the International Monetary Fund (IMF 2023).

Nevertheless, developing countries have demonstrated a significant surge in academic publications in the millennium era. Factors such as the widespread availability and affordability of information and communication technologies, enhanced information accessibility, and globalization have played pivotal roles in this uptick (Al-Ansi, Suprayogo, and Abidin 2019). The progress of developing countries in addressing climate change and entrepreneurship in recent years is evident in Table 4, showcasing the substantial increase in academic publications. The Russian Federation (14), China (11), and India (8) lead the pack in 2023. Especially, the Russian Federation had no publications on this topic before 2022, while China had two and India had only one before 2015. This surge in publications from developing countries over the past decade aligns with the literature on the globalization of academic studies.

While developed countries currently dominate the landscape of research on climate change and entrepreneurship, the initial spark of this critical intersection originated in unexpected corners of the globe. Thailand and Zimbabwe stand out as the first countries to publish academic work on this intertwined theme in 2001 and 2003, respectively. This seemingly minor detail holds significant weight, hinting at the diverse perspectives and proactive approaches that can emerge from developing economies facing the brunt of climate change. With a wealth of literature highlighting the disproportionate vulnerability of developing nations to climate change impacts (WEF 2023), it is understandable that these countries feel compelled to seek innovative solutions. This urgency manifests in increased research on the intersection of climate change and entrepreneurship. The heightened vulnerability fueled a sense of urgency and a need to explore innovative solutions, which led them to research climate change and entrepreneurship. The first of these studies, by Priambodo and Kumar (2001), focuses on Indonesia and the contributions of small and medium enterprises (SMEs) and entrepreneurs to CO_2 emissions and climate change. They conclude that the sectors that emit the most CO_2 in this regard are textiles, fabricated metals and chemicals, and food and beverages. On the other hand, in a study conducted by Magadza (2003) the emergence of climate change problems in Africa and Zimbabwe and adaptation strategies for climate change are discussed. He concludes that for African governments' climate change adaptation initiatives, the private sector may be the most efficient strategy through the necessary technology transfer, development of entrepreneurship, and exploitation of market forces. Chirambo (2016, 2017, 2018, 2019, 2021a, 2021b, 2023), who has the highest number of publications on 'entrepreneurship and climate change' also focuses on Africa and treats entrepreneurship as a remedial approach. Furthermore, through bibliographic coupling analysis, we observe that the studies in one of the clusters (Cluster #7) are centered on Africa. All of these findings collectively suggest that entrepreneurship is acknowledged as Africa's foremost weapon in combating the destructive impacts of climate change.

5.1.3 | Explaining Popular Topics via Co-Occurrence Analysis of Keywords in Publications and Bibliographic Coupling Analysis

The concept of "sustainability" embodies the capacity to fulfil present needs without compromising the needs of future generations, according to the World Commission on Environment and Development (WCED 1987). The introduction of the SDGs as part of the 2030 Agenda for Sustainable Development by the UN seeks to foster development across economic, social, and environmental domains (UN 2023). Both sustainability and the SDGs are directly linked to climate change, emphasizing the imperative of transitioning to a sustainable economy to safeguard against global crises such as climate change. Concurrently, during a turbulent global phase with events like the COVID-19 pandemic and extreme weather, the role of entrepreneurship in fostering inclusive and sustainable development has become increasingly prominent (UN 2020).

The findings from both co-occurrence analysis of keywords and bibliographic coupling analysis strongly reinforce this perspective. Sustainability emerges as the most prominent theme, alongside entrepreneurship and climate change. Additionally, out of the 25 keywords examined, 9 are directly relevant to sustainability (sustainability, sustainable development goals, sustainable development, circular economy, green entrepreneurship, renewable energy, sustainable entrepreneurship, climate policy, and environmental entrepreneurship). Conversely, among the 17 clusters/themes identified through bibliographic coupling analysis, 11 (*Clusters/Themes 2, 3, 4, 5, 6, 7, 8, 11, 12, 14, 17*) specifically highlight sustainability. All these findings corroborate that if there were a book titled "Entrepreneurship in Combatting Climate Change," sustainability would be an indispensable subject matter, serving as the inaugural unit.

Entrepreneurs play a crucial role in the transformative process by conceptualizing "innovative solutions" that encompass ecological, social, and economic values (Diepolder, Weitzel, and Huwer 2021). Entrepreneurship holds promise in addressing the challenges of climate change and facilitating the necessary innovations. At this juncture, "innovation" stands out as a paramount entrepreneurial tool. Schumpeter (1934) defines an entrepreneur as "a person who does new things or things already being done in a new way." In essence, innovation is the pivotal activity or function of entrepreneurial individuals. According to the theory, entrepreneurs are expected to overcome psychological and social resistances hindering the pursuit of novel endeavors (Sweezy 1943). Climate change is a multifaceted global issue with social, political, and economic dimensions (Ojo and Oluwatayo 2023). Furthermore, ongoing discussions on sustainable development highlight the critical role of innovation in achieving sustainability (Youssef, Boubaker, and Omri 2018). Hence, the interconnection of the keywords "sustainability," "innovation," and "sustainable development goals" comes as no surprise (Azmat et al. 2023).

Besides, the results of the bibliographic coupling analysis further support the findings of the literature and co-occurrence analysis, with a particular emphasis on entrepreneurs driving innovations in the fight against climate change.

In summary, an examination of the results from the co-occurrence and bibliographic coupling analyses reveals a thematic alignment with existing literature. Significantly, terms such as "sustainability," "innovation," and "sustainable development goals" prominently emerge in academic investigations concerning climate change and entrepreneurship, as depicted in Tables 5 and 6. This finding serves to substantiate the prevailing body of literature on this subject.

Upon reviewing the additional keywords and themes highlighted in the analyses, it is pertinent to note the following emphases elucidated in the literature:

Climate Policies, Policy Entrepreneurs and Renewable Energy: In the quest to address climate change, formulating robust "climate policies" emerges as imperative. The involvement of "social entrepreneurs," often referred to as "policy entrepreneurs," is essential for fostering social and political innovation (Schartinger et al. 2017). The keywords "policy entrepreneurship" and "policy innovation" highlight the importance of actively shaping local and global policies to guide regulations (Mintrom and Norman 2009). Failure to enact substantial policy changes or a lack of focus by enterprises on environmental and social considerations may accelerate the interconnected issues of climate change, biodiversity loss, food security, and natural resource consumption. Nations should be encouraged to actively seek sustainable solutions like "renewable energy" (Rossiter and Smith 2018; WEF 2023). Reminding policymakers of their responsibilities in decisions affecting societies and nature is crucial, emphasizing solutions such as "climate policies" or "renewable energy" (Philip, Emir, and Udemba 2022).

Sustainable Development Goals (SDGs), Social Innovation and COVID-19: The pursuit of "SDGs" is integral to sustainable development, and the impact of "COVID-19" has affected progress toward these goals. Economic health depends on public and environmental health. The path to recovery after the epidemic is finding new ways to redesign strategies, actions, and perspectives (Lim 2022). Additionally, the need for "social innovation" and "social entrepreneurship" to address private sector entrepreneurship and solve social problems is recognized (Bozhikin, Macke, and da Costa 2019). IDRC is a good case for this scope. As part of Canada's foreign affairs and development efforts, IDRC is actively fostering social innovation and entrepreneurship to address the SDGs while tackling the intersecting challenges of COVID-19, particularly by supporting research initiatives that empower marginalized communities and promote gender equality and economic inclusion (IDRC 2024).

Circular Economy: Increasing global industrialization and reliance on non-renewable energy sources contribute to climate change. The adoption of a "circular economy" approach aimed at waste reduction across all sectors assumes paramount importance in advancing recycling practices and utilizing natural resources judiciously to foster sustainable development (Durán-Romero et al. 2020; Marchesi and Tweed 2021; Yang et al. 2022). Achieving a circular economy requires systematic change, and strengthening these policies is crucial in the face of environmental challenges and climate change (Kirchherr, Reike, and Hekkert 2017).

Digital Economy: While climate change poses a significant threat to companies, the intersection of "digital economy" and sustainability has led to noteworthy developments. The co-occurrence analysis highlights the prominence of the "digital economy" in 2023, with research focusing on applications such as IoT, Fintech, and e-commerce to develop climate change-sensitive enterprises (Popkova 2023). The digitization trend has become a competitive force affecting companies, especially in addressing climate change. In recent years, the intersection of digitalization and the need for sustainability has led to some seminal research concepts and startups (George, Merrill, and Schillebeeckx 2021). Additionally, ensuring the sustainability of "digital economy" tools and pioneering advancements in the digital economy emerge as essential components in the collective effort against climate change (Popkova 2023).

The results of the bibliographic coupling analysis are parallel to those of co-occurrence analysis and relevant literature. Some of the emerging themes among the 17 clusters include emphasizing the role of policy entrepreneurship as a tool for action and governance in mitigating climate change and ecological risks, as well as drawing attention to the importance of social entrepreneurship and social innovation. Additionally, mention is made of the key role entrepreneurship plays in achieving the sustainable development goals and the circular economy objectives. These critical issues are consistently highlighted by the bibliometric analysis. Therefore, our findings contribute theoretically by making visible the themes researchers will encounter when evaluating "entrepreneurship and climate change" issues.

5.2 | Practical Implications

When we look at the events experienced in the world due to climate change after 2000, it can be seen that the number of scientific studies addressing these two issues together is insufficient; however, there is also a noticeable increase in such studies. Therefore, we predict that the outputs obtained within the framework of this study will make practical contributions to three different groups.

5.2.1 | Implications for Entrepreneurs

First, entrepreneurship plays a pivotal role in addressing the multifaceted challenges posed by climate change. Addressing climate change through entrepreneurial ventures poses not only a significant opportunity for startup success (securing funding, growth, accurate needs identification, etc.) but also a chance to impact humanity positively. Entrepreneurs should recognize the opportunities embedded within the challenges climate change presents. However, navigating these opportunities requires entrepreneurs to focus on and critically assess changing trends for insightful guidance. Consequently, reorienting the entrepreneurial ecosystem toward the well-being of future generations becomes crucial. The activities and projections

carried out by organizations such as Amazon (2024), ANDE (2024), CCE (2024), EIT Climate-KIC (2024), and IDRC (2024), which have been previously mentioned, can serve as a guiding light for entrepreneurs in this regard. As highlighted by these examples, the ecosystem necessitates the emergence of green and sustainable entrepreneurs who can actively contribute to social and policy innovation, possess environmental consciousness, and advocate for achieving SDGs and the circular economy. Highlighting the necessity of this paradigm shift in the entrepreneurial landscape constitutes a valuable practical contribution to future research.

Furthermore, while academic interest in climate change parallels the evolving industrial landscape, regions with limited publications on the topic still exhibit nascent environmental awareness. This dearth of academic exploration in these areas may obscure the true extent of the existing interest and the gravity of the situation. Additionally, due to the inherent lag between industry trends and academic reflection, a burgeoning interest in certain sectors might not yet be visible in published research. This gap can pose threats and unexpected opportunities for entrepreneurs in these regions.

Consultation, financial support, and incentives like grants are widely available for potential initiatives targeting developing regions and disadvantaged ecosystems. Many organizations, both national and global, such as ANDE (2024), CCE (2024), EIT Climate-KIC (2024), and IDRC (2024), are eager to foster progress in this area, particularly in developing economies. Entrepreneurs in these regions should definitely explore these opportunities. For example, EIT Climate-KIC (2024) supports the establishment of circular economy ecosystems, the creation of convenient infrastructure for climate entrepreneurs, and climate-based innovative initiatives aimed at keeping global warming below 1.5°C, particularly in Africa and other developing regions worldwide. CCE (2024) asserts that it has utilized over $2,500,000 in funding to support climate-focused entrepreneurship in emerging economies by providing programming, training, mentorship, and access to capital for climate ventures. ANDE (2024) announces its commitment to supporting green entrepreneurs and small and growing businesses (SGBs) to advance global SDGs, promote climate actions, and provide clean water, sanitation, and affordable, clean energy by 2030.

5.2.2 | Implications for Researchers

The undeniable reality of worsening climate change has fueled a burgeoning research landscape in this domain, indicating an open and fertile field for academic inquiry. Interestingly, the geographical distribution of studies examining climate change and entrepreneurship (Figures 3 and 4) offers valuable insights for researchers regarding regions with heightened interest in this critical intersection. Developed nations, particularly the USA, the UK, and EU member states demonstrably prioritize climate change mitigation and view entrepreneurship as a potent tool for tackling social, environmental, and political challenges. The organizations and activities directly supported by the US government and the EU, such as CCE (2024) and EIT Climate-KIC (2024), serve as evidence of their clear support in this matter, corroborating our findings. These commitments often manifest in tangible support for relevant research and projects through initiatives like data sharing, resource allocation, and dedicated funding programs. However, attributing the disparity in academic output to regional interest would be overly simplistic. Developed countries with significant publication records attract researchers due to robust academic infrastructure and resources (Galvez et al. 2000). Therefore, the volume of academic publications may primarily reflect the level of broader institutional support for research rather than solely signifying the priority assigned to the subject at hand.

Recognizing this, organizations and research centers in regions with limited scholarly output have an opportunity to bridge the gap by offering enticing research opportunities and funding mechanisms. This initiative could unlock a wave of transformative work in these areas, with researchers potentially becoming regional pioneers. Studies led by researchers from underrepresented regions could greatly enhance existing literature by evaluating entrepreneurship within the context of their unique regional climate change challenges. The regions with a scarcity of academic studies that we have identified are also acknowledged by organizations like IDRC (2024), which support and fund in-depth and comprehensive research. For instance, the IDRC supports research on various aspects of entrepreneurship intersecting with climate change, including climate-resilient entrepreneurship, clean energy initiatives, circular economy models, climate-smart agriculture, climate finance mechanisms, climate information services, green entrepreneurship ecosystems, and social entrepreneurship addressing climate challenges. It would be advantageous for researchers aiming to conduct studies on climate entrepreneurship to consider the incentives provided by organizations such as IDRC and national agencies.

5.2.3 | Implications for Policymakers

The intersection of entrepreneurship and climate change has risen to the forefront of policy discourse among nations, presenting a compelling opportunity for positive interventions. Implementing targeted regulations, incentives, and national funds can effectively galvanize entrepreneurial activity toward addressing climate challenges at local and global scales.

Policymakers hold a crucial role in shaping this endeavor. Their focus should extend beyond establishing climate policies to encompass fostering social capital, crafting innovative policy frameworks, and catalyzing the transition toward a circular economy. Through such comprehensive initiatives, policymakers can pave the way for concrete progress toward the SDGs.

A critical aspect of this undertaking lies in prioritizing incentives that encourage cross-disciplinary research collaboration and strategic resource allocation. Prioritizing support for fragile regions should be a guiding principle. This requires that resources first reach communities most vulnerable to climate disruptions. The World Bank, IMF, WEF, UN, and other international organizations can play a pivotal role in bolstering this effort, particularly by supporting territories such as Africa disproportionately affected by climate disasters. Fostering open dialogue between policymakers of resource-scarce nations and

global funding bodies, alongside targeted incentives, and research funding, can initiate a virtuous cycle of knowledge production and financial assistance. This, in turn, contributes significantly to global recovery efforts.

Entrepreneurs, as critical drivers of economic development, should be central to regulatory and policy frameworks shaped by principles like the SDGs, as demonstrated by the co-occurrence analysis of keywords and bibliographic coupling analysis. Furthermore, the burgeoning field of entrepreneurship-centered research increasingly takes the circular economy approach seriously as a critical weapon in the fight against climate change. This underscores the transformative potential of entrepreneurs in driving the adoption of circular practices. Policymakers should leverage this potential by incentivizing and empowering entrepreneurs to lead ecosystem transformations and embed circular economy principles within their regions.

Finally, policymakers in regions with limited academic output should conduct a thorough internal assessment to identify and address knowledge gaps and administrative inefficiencies. By actively engaging with and empowering entrepreneurs to combat climate change and foster academic inquiry, these regions can become active participants in shaping a sustainable future.

5.3 | Limitations and Future Research Directions

While this study significantly contributes to the expanding literature, several limitations warrant consideration for future research endeavors.

First, a notable limitation lies in the study's exclusive reliance on articles from the Scopus database. Restricting the analysis to the Scopus database, while comprehensive, excludes potentially relevant publications from other databases like Web of Science and Google Scholar. Future research could overcome this limitation by incorporating a broader array of databases or amalgamating data from different sources. This approach would enhance the generalizability of results.

Second, the study's scope was confined to specific document types such as articles, books, and book chapters, excluding others like conference papers, reviews, and editorials. Additionally, certain valuable data types, such as the "number of citations, co-citation, co-authorship," were omitted from the analysis. These exclusions, while intended to maintain focus, represent significant limitations. Future researches might consider incorporating these criteria into the overall bibliometric analysis to provide different perspectives on the field.

A third limitation arises from the nature of bibliometric analyses, wherein the risk of including irrelevant publication data exists due to the large dataset. Future studies should address this limitation by employing more rigorous filtering mechanisms to ensure the relevance and accuracy of the data. Also, while comprehensively assessing entrepreneurship in the context of climate change, the study primarily emphasized the "impact of entrepreneurship on climate change." This focus potentially overlooked insights into "the impact of climate change on entrepreneurship." Future research could tilt the balance toward "the impact of climate change on entrepreneurship" to gain a fresh perspective and enrich the understanding of both sides of the equation.

Finally, the fact that the sources of studies on the digital economy are similar poses a limitation. The digital economy has also been evaluated as a playground for climate-focused entrepreneurship. This emergent theme warrants further exploration to better comprehend its dynamics.

We can continue to deepen our understanding of the intricate and vital relationship between climate change and entrepreneurship by addressing these limitations and delving into promising future research directions. This knowledge will empower us to develop proactive strategies, innovative solutions, and effective collaborations to create a more sustainable future for all.

6 | Conclusion

Among contemporary global risks, those arising from climate change stand preeminent. Its wide-ranging and long-lasting impacts threaten the very future of humanity. However, just as entrepreneurship has provided solutions in numerous fields, it holds immense potential to mitigate and adapt to the challenges posed by climate change. This burgeoning field has become a central topic of academic inquiry, fueling a growing body of research.

This research contributes to comprehending the academic landscape surrounding the intersection of "entrepreneurship and climate change." The initial steps involve a thorough exploration through a literature review and the establishment of a theoretical framework, setting the stage for this investigation. This involves scrutinizing previous studies that delve into the past, present, and future aspects of climate change, with a specific emphasis on entrepreneurial studies within the context of climate change.

Employing a bibliometric research method, the study analyzes 387 academic publications (articles, books, and book chapters) indexed in the Scopus database between 2001 and 2023. Quantitative analysis techniques are employed to explore publication trends, leading authors, geographic distribution of publications, co-occurring keywords, and bibliographic coupling. Furthermore, it tracks the current situation and shifts in research focus by analyzing prominent keywords based on the average year of publication, and by determining the major themes of coupled clusters of publications.

The findings reveal a consistent upward trend in publications addressing the nexus of climate change and entrepreneurship, with a notable surge observed in 2023. However, while developed countries demonstrate a historical dominance in publication numbers, there has been a significant increase in developing nations in recent years. Notably, the analysis uncovers a thematic convergence, with concepts like "sustainability," "innovation," and "sustainable development goals" frequently intersecting with discussions of climate change and entrepreneurship. A key finding emerging from the study is the substantial responsibility attributed to entrepreneurship in addressing climate change. Emphasizing the predominant role of entrepreneurship in

reducing and adapting to climate change highlights its pivotal power for achieving sustainable development.

Finally, a pivotal trend change in academic publishing from "institutional entrepreneurship" to the "digital economy" has been emphasized. Interestingly, the COVID-19 pandemic also affects this field. In essence, the results of this study hold practical implications for entrepreneurs, researchers, and policymakers, offering valuable insights to inform their next steps in addressing the intricate intersection of entrepreneurship, climate change, and global challenges.

Author Contributions

Talha Karadayi: conceptualization, investigation, writing–original draft, methodology, visualization, writing–review and editing, software, resources. **Selim Yazici**: writing–review and editing, conceptualization, validation, project administration, resources. **Gökçe Akdemir Omur**: supervision, writing–review and editing, conceptualization.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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