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Scientific Frontier Mapping of Circular Entrepreneurship: Emerging Themes and Knowledge Dynamics (2015–2025)

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ABSTRACT

This study aims to map the scientific frontier of circular entrepreneurship by examining its emerging themes, intellectual foundations, and evolving knowledge dynamics over the period 2015–2025. Using a science-mapping approach based on bibliometric data retrieved from the Scopus database, the study applies co-citation analysis, bibliographic coupling, keyword co-occurrence, and network visualizations with VOSviewer to uncover the structural and conceptual development of the field. The findings reveal that circular entrepreneurship is anchored by the concept of the circular economy and increasingly integrated with entrepreneurship, innovation, and sustainability-oriented business models. Thematic clustering indicates four dominant research streams: sustainable and social entrepreneurship, entrepreneurial innovation and firm dynamics, environmental management and impact, and circular business models with stakeholder engagement. Temporal and density analyses further demonstrate a shift from conceptual and normative discussions toward applied, ecosystem-based, and impact-oriented research. The study provides a comprehensive overview of how circular entrepreneurship has matured into an interdisciplinary and globally connected research domain, offering a structured foundation for future theoretical development, empirical investigation, and policy-oriented research.

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1. INTRODUCTION

Circular entrepreneurship has emerged as a critical paradigm in the global transition toward sustainable and regenerative economic systems. Rooted in the principles of the circular economy, this entrepreneurial approach emphasizes value creation through resource efficiency, waste minimization, product life-cycle extension, and innovative business models that decouple growth from environmental degradation [1], [2]. As industries confront escalating ecological constraints and societal expectations for sustainable practices, circular entrepreneurship serves as a transformative mechanism capable of driving systemic change [3]. Scholars have increasingly recognized that entrepreneurs are uniquely positioned to challenge incumbent linear models, experiment with novel resource loops, and cultivate adaptive solutions to

environmental pressures [4]. Consequently, the intellectual landscape surrounding circular entrepreneurship has experienced rapid expansion, attracting multidisciplinary attention from business, environmental science, innovation studies, and policy research [5].

The growing relevance of circular entrepreneurship is further amplified by global sustainability agendas, including the United Nations Sustainable Development Goals (SDGs), which encourage inclusive innovation and responsible production [6]. Governments and international organizations have begun integrating circularity into their development frameworks, reinforcing the entrepreneurial ecosystem that supports circular business practices [7]. This institutional momentum has prompted scholars to investigate the interplay between policy dynamics, entrepreneurial motivations, and the structural conditions enabling circular innovation [8], [9]. With the proliferating number of studies, the scientific domain has evolved into a complex body of knowledge characterized by diverse theoretical orientations, methodological approaches, and application contexts. Understanding how these strands converge is essential for comprehending the progression and boundaries of circular entrepreneurship as an academic field.

In parallel with policy shifts, technological advancements have accelerated opportunities for circular entrepreneurs. Innovations such as digitalization, the Internet of Things (IoT), additive manufacturing, and advanced material recovery systems have enabled new value loops and circular business models that were previously unfeasible [10]. These technologies allow entrepreneurs to monitor product life cycles, optimize resource flows, and design service-oriented offerings that enhance product longevity [11]. The convergence of sustainability-driven strategies with cutting-edge technologies has shaped a distinctive domain where entrepreneurial creativity is supported by data-driven insights and sophisticated resource management tools. As research evolves, scholars have begun mapping how technological affordances influence entrepreneurial pathways, market competitiveness, and circular innovation ecosystems.

Another significant dimension in the evolution of circular entrepreneurship knowledge is the growing interest in socio-cultural dynamics. Entrepreneurial decisions are influenced not solely by economic incentives but also by values, norms, and community-based drivers that shape sustainability-oriented behavior [12], [13]. In many contexts, circular businesses emerge from social entrepreneurship traditions, where community resilience, ethical production, and local resource stewardship are central motivations. This intersection between social sustainability and circular business innovation has broadened the conceptual boundaries of the field, highlighting the role of cultural narratives, collaborative networks, and consumer engagement in scaling circular solutions. Researchers have increasingly mapped these dynamics to understand how social context shapes entrepreneurial trajectories and the diffusion of circular practices across industries.

Despite the substantial advancements in circular entrepreneurship discourse, the field remains highly fragmented. Terminologies, theoretical frameworks, and methodological approaches vary widely across disciplines, creating conceptual ambiguities and gaps in cumulative knowledge development [14]. This fragmentation complicates the task of identifying coherent patterns, emerging research fronts, and intellectual trajectories. As the body of literature expands, the challenge is no longer only about generating new insights but also about systematically organizing existing knowledge. Scientific frontier mapping offers a powerful tool for addressing this complexity. By analyzing publication trends, thematic clusters, and knowledge flows, frontier mapping provides an integrated perspective on how circular entrepreneurship research is advancing,

where it is heading, and what critical issues remain underexplored.

Although research on circular entrepreneurship has grown extensively, there is still no comprehensive understanding of the field's intellectual structure, emerging core themes, or evolving knowledge dynamics. Existing studies are often isolated within specific lenses without capturing how these perspectives interact to shape the scientific frontier. This fragmentation inhibits theoretical consolidation, limits interdisciplinary learning, and creates uncertainty regarding future research priorities. Consequently, scholars, practitioners, and policymakers lack a clear map of how circular entrepreneurship knowledge has developed and which areas require deeper investigation. A systematic frontier-mapping effort is needed to address this gap. The objective of this study is to conduct a scientific frontier mapping analysis of circular entrepreneurship to uncover its emerging themes, conceptual structures, and evolving knowledge dynamics.

2. METHOD

This study employed a bibliometric and scientific mapping approach to systematically analyze the intellectual structure and knowledge evolution of circular entrepreneurship research. Bibliometric methods were selected because they provide quantitative insights into publication patterns, author networks, thematic clusters, and citation linkages that define the development of a research field. The analysis focused on peer-reviewed journal articles, conference papers, and review papers, ensuring comprehensive coverage of scholarly contributions relevant to circular entrepreneurship. To construct the dataset, publications were retrieved from Scopus Database using a structured search strategy that included keywords related to "circular entrepreneurship," "circular business models," "sustainable entrepreneurship," and "circular innovation." Duplicate entries were removed, and inclusion criteria were applied to filter out irrelevant materials.

After compiling the dataset, science-mapping techniques were applied to uncover the knowledge structure of the field. Co-citation analysis, bibliographic coupling, and keyword co-occurrence mapping were employed to reveal the intellectual foundations and thematic clusters within the literature. Co-citation analysis helped identify seminal works and dominant theoretical influences, while bibliographic coupling traced contemporary research convergences. Keyword co-occurrence mapping, supported by VOSviewer software, enabled the detection of emerging themes and conceptual relationships that structure the scientific frontier of circular entrepreneurship.

3. RESULT AND DISCUSSIONS

3.1 Network Visualization

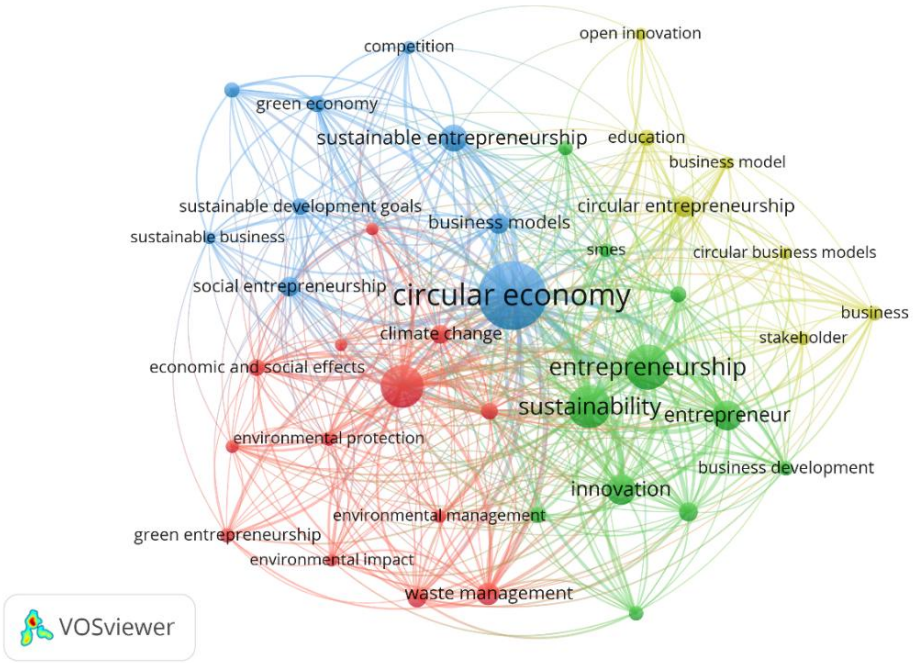

Figure 1. Network Visualization
Source: Data Analysis Result, 2025

Figure 1 reveals circular economy as the dominant and most central concept structuring the scientific frontier of circular entrepreneurship. Its large node size and dense connections indicate that it functions as the primary conceptual anchor, linking sustainability-oriented discourse with entrepreneurial logic. Closely connected terms such as entrepreneurship, sustainability, and innovation demonstrate that circular entrepreneurship research is not treated as a standalone niche, but rather as an integrative field combining environmental objectives with business creation, value capture, and innovation dynamics. A second prominent feature of the map is the strong clustering around entrepreneurship and innovation, shown by the green cluster. Keywords such as entrepreneurship, innovation, business development, SMEs, and sustainability entrepreneur suggest that scholars increasingly frame circular entrepreneurship through firm-level capabilities and innovation processes. This cluster reflects a managerial and strategic orientation, emphasizing how entrepreneurs operationalize circular principles through innovation, scalability, and organizational development, particularly within small and medium-sized enterprises.

Table 1. Thematic Clusters in Circular Entrepreneurship Research

Cluster Color	Dominant Theme	Key Keywords	Conceptual Focus
Blue	Sustainable & Social Entrepreneurship	circular economy, sustainable entrepreneurship, SDGs, green economy, social entrepreneurship	Normative and policy-driven perspectives linking entrepreneurship with sustainability transitions
Green	Entrepreneurial Innovation & Firm Dynamics	entrepreneurship, innovation, SMEs, sustainability entrepreneur, business development	Firm-level innovation, opportunity creation, and business growth under circular logic
Red	Environmental Management & Impact	waste management, environmental protection, climate change, environmental impact	Operational and environmental outcomes of circular entrepreneurial activities
Yellow	Circular Business Models & Stakeholders	circular business models, business model, stakeholders, education, open innovation	Value creation mechanisms, stakeholder engagement, and learning processes

Source: Data Analysis, 2025

The red cluster highlights environmental management and impact, emphasizing practical and outcome-oriented concerns such as waste management, environmental protection, climate change, and environmental impact. This cluster shows how circular entrepreneurship research remains deeply connected to environmental problem-solving, positioning entrepreneurs as agents who translate ecological challenges into economic opportunities. The strong links between this cluster and both entrepreneurship and circular economy nodes indicate that environmental outcomes are increasingly examined alongside business viability. The yellow cluster represents circular business models and stakeholder engagement, with keywords such as circular business models, stakeholder, education, and open innovation. This reflects a growing research frontier focused on how value is co-created within networks involving customers, policymakers, educators, and partners. The presence of education and open innovation signals an emerging emphasis on capability-building, knowledge diffusion, and collaborative experimentation as enablers of circular entrepreneurial ecosystems.

3.2 Overlay Visualization

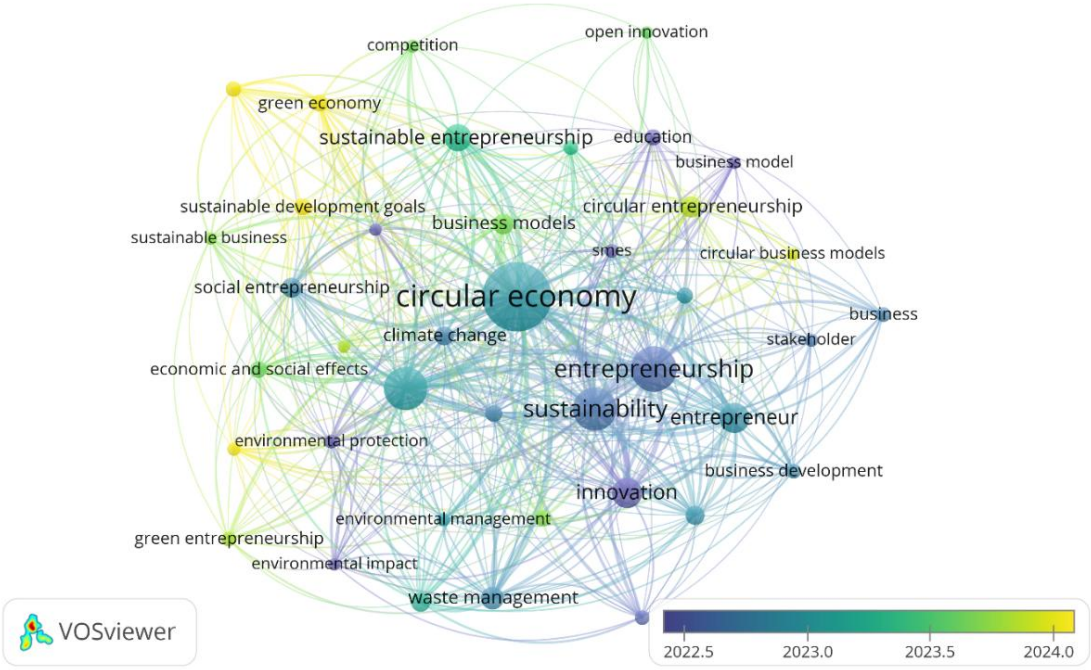

Figure 2. Overlay Visualization
Source: Data Analysis Result, 2025

Illustrates the temporal evolution of circular entrepreneurship research, with color gradients indicating the average publication year of keywords. Core concepts such as circular economy and entrepreneurship appear in earlier-to-mid periods (blue–teal tones), confirming their role as foundational anchors of the field. These terms form the structural backbone around which newer concepts gradually emerge, suggesting that early research focused on establishing conceptual links between circular economy principles and entrepreneurial activity. More recent themes, indicated by green to yellow colors, highlight the shift toward applied and ecosystem-oriented perspectives. Keywords such as circular business models, stakeholder, education, open innovation, and green economy appear closer to the 2023–2024 range, signaling a growing interest in how circular entrepreneurship is operationalized through collaborative networks, learning processes, and business model innovation. This trend reflects a maturation of the field, moving beyond conceptual debates toward implementation, governance, and capability-building dimensions. At the frontier level, the overlay suggests an increasing convergence between sustainability outcomes and entrepreneurial mechanisms. Emerging attention to environmental protection, economic and social effects, and sustainable development goals indicates that recent studies are more explicitly linking circular entrepreneurship to measurable impact and policy relevance.

3.3 Citation Analysis

Table 1. Most Cited Article

Citations	Author and Year	Title
420	[15]	Unlocking value for a circular economy through 3D printing: A research agenda
380	[16]	Sustainable business models: A review
256	[17]	Eco-innovation and firm growth in the circular economy: Evidence from European small- and medium-sized enterprises
225	[18]	A new circular business model typology for creating value from agro-waste
186	[19]	Green recovery in the mature manufacturing industry: The role of the green-circular premium and sustainability certification in innovative efforts
185	[20]	From circular business models to circular business ecosystems
179	[21]	The theory of economic development
147	[22]	Embracing the variety of sustainable business models: A prolific field of research and a future research agenda
140	[23]	The circular economy meets artificial intelligence (AI): understanding the opportunities of AI for reverse logistics

Source: Scopus, 2025

3.4 Density Visualization

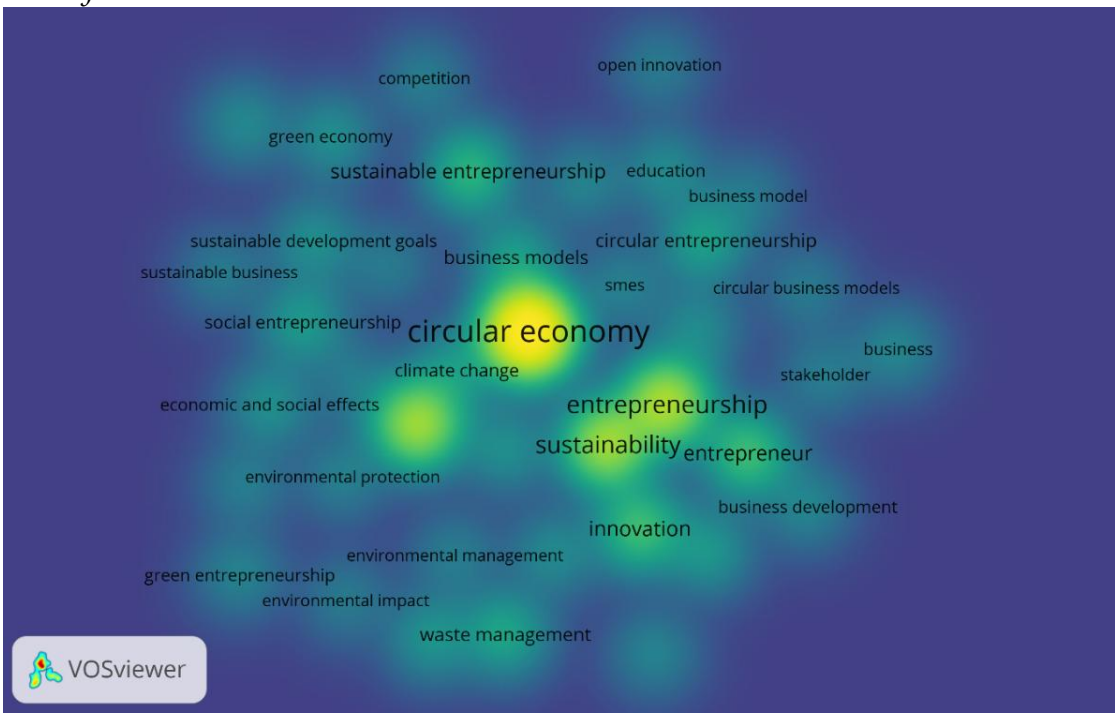

Figure 3. Density Visualization
Source: Data Analysis Result, 2025

Figure 3 highlights circular economy as the most intense hotspot in the literature, confirming its role as the core knowledge nucleus of circular entrepreneurship research. Surrounding high-density areas such as entrepreneurship, sustainability entrepreneur, and innovation indicate that scholarly attention is heavily concentrated on linking circular economy principles with entrepreneurial action and innovation-driven value creation. This concentration suggests that the field has achieved a stable

conceptual center where sustainability and entrepreneurship are increasingly examined as mutually reinforcing rather than separate domains. Moderate-density zones around business models, climate change, environmental protection, and waste management reflect secondary but well-established research streams that operationalize circular entrepreneurship in practice. These areas represent applied discussions on environmental impact, managerial mechanisms, and sustainability outcomes. In contrast, lower-density terms such as open innovation, education, and stakeholder point to emerging or underexplored niches, indicating potential directions for future research focused on ecosystem governance, learning processes, and collaborative innovation within circular entrepreneurial systems.

3.5 Co-Authorship Network

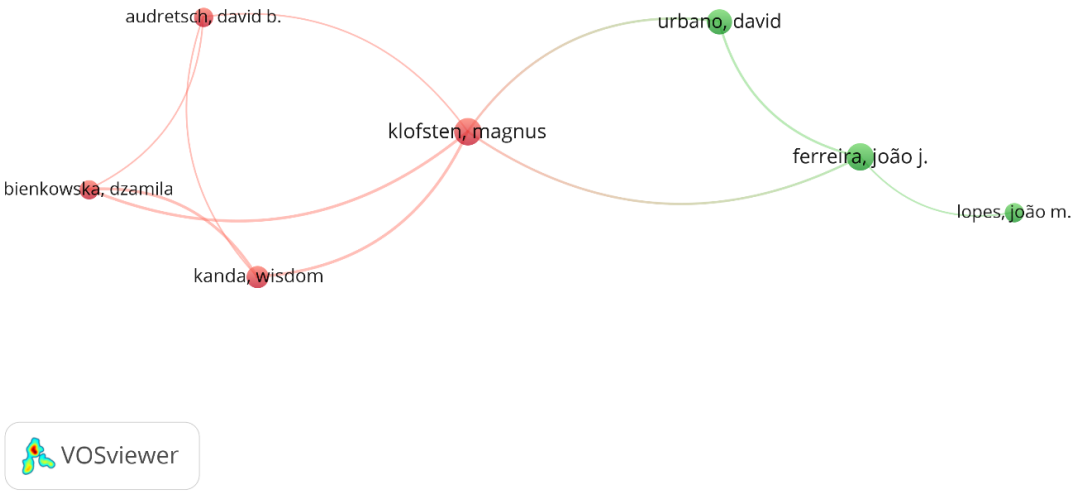

Figure 4. Author Visualization
Source: Data Analysis Result, 2025

Figure 4 reveals a clearly structured intellectual linkage within circular entrepreneurship research, with Klofsten, Magnus occupying a central bridging position between two distinct scholarly clusters. The red cluster (including Audretsch, B., Kanda, Wisdom, and Bienkowska, Dzamila) reflects a strong foundation in entrepreneurship systems, innovation policy, and regional or institutional perspectives. In contrast, the green cluster (Urbano, David; Ferreira, João J.; and Lopes, João M.) represents a complementary stream emphasizing entrepreneurial orientation, sustainability-driven firm behavior, and strategic management. The positioning of Klofsten as a connector indicates his role in integrating innovation-system thinking with sustainability-oriented entrepreneurship, suggesting that the scientific frontier of circular entrepreneurship is shaped by cross-fertilization between institutional–policy approaches and firm-level entrepreneurial strategy research.

Figure 5. Affiliation Visualization
Source: Data Analysis Result, 2025

Figure 5 shows a selective and highly centralized pattern of knowledge production in circular entrepreneurship research. A small number of universities act as key connectors across otherwise loosely linked institutional clusters. Universitat Autònoma de Barcelona occupies a central bridging position, linking Northern and Southern European institutions such as Linköping University and Universidade da Beira Interior. On the left side, research units and departments focused on management and innovation studies form a compact cluster, indicating strong intra-institutional collaboration. Overall, the sparse structure suggests that while the field is anchored by a few influential academic hubs, there remains substantial opportunity for broader cross-institutional and transnational collaboration to advance the scientific frontier of circular entrepreneurship.

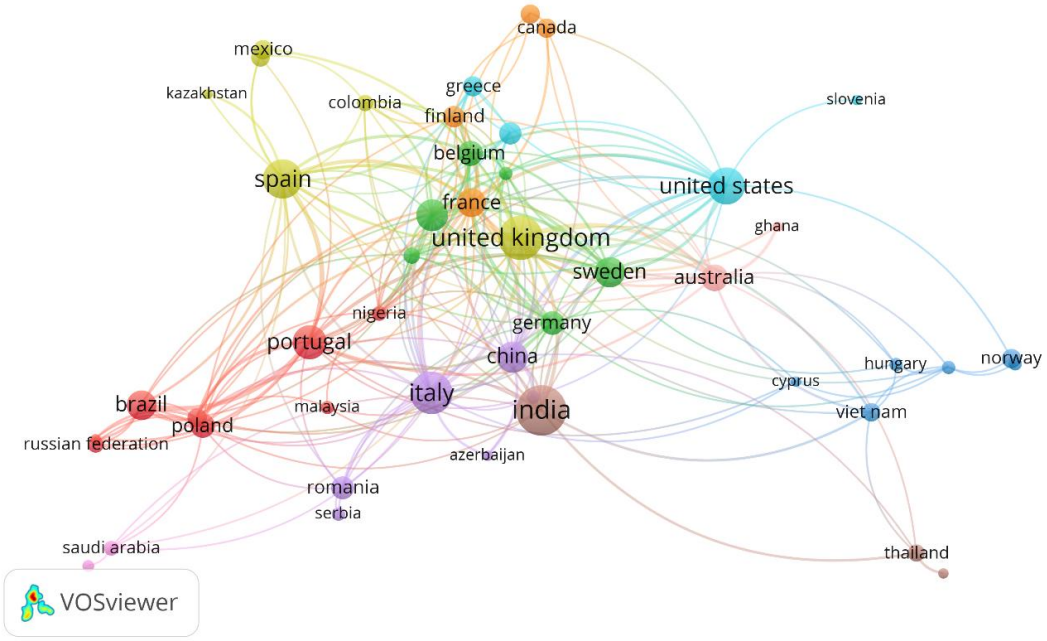

Figure 6. Country Visualization
Source: Data Analysis Result, 2025

Figure 6 reveals a globally interconnected yet regionally clustered research landscape in circular entrepreneurship. The United Kingdom emerges as a central hub, maintaining strong collaborative ties with European countries such as France, Germany, Sweden, Belgium, and Spain, as well as linkages to the United States and Australia. This positioning highlights Europe's leading role in shaping the field, particularly through sustainability and circular economy policy agendas. At the same time, emerging contributors such as India, China, and Brazil occupy strategically connected positions, indicating growing engagement from developing and transition economies. The presence of peripheral but linked countries across Asia, Africa, and Eastern Europe suggests that circular entrepreneurship research is increasingly global in scope, though still driven by a limited number of highly connected national research hubs.

3.6 Discussion

a. Practical Implications

The findings of this study offer several practical insights for key stakeholders involved in advancing circular entrepreneurship. For entrepreneurs and SMEs, the prominence of themes such as circular business models, innovation, and sustainability-oriented entrepreneurship suggests that competitive advantage increasingly stems from integrating circular principles into core business strategies rather than treating sustainability as an add-on. Entrepreneurs are encouraged to adopt innovation-driven approaches such as waste valorization, product-life extension, and collaborative value creation to translate environmental challenges into viable market opportunities. For policymakers and support

institutions, the strong linkage between circular entrepreneurship, sustainability goals, and environmental management highlights the importance of ecosystem-based policy interventions. These include targeted incubation programs, incentives for circular business model experimentation, and stronger linkages between entrepreneurship support systems and circular economy regulations. Meanwhile, educational institutions and innovation intermediaries can leverage the emerging focus on education and open innovation by embedding circular entrepreneurship into curricula, training programs, and living labs, thereby strengthening entrepreneurial capabilities aligned with sustainability transitions.

b. Theoretical Contribution

From a theoretical perspective, this study contributes to the literature by systematically mapping the scientific frontier of circular entrepreneurship and clarifying its intellectual and conceptual structure. The results demonstrate that circular entrepreneurship is not merely a subfield of either circular economy or entrepreneurship studies, but an integrative domain where sustainability logic, entrepreneurial agency, and innovation processes intersect. By combining co-citation, bibliographic coupling, and keyword co-occurrence analyses, this research identifies how foundational theories such as sustainable entrepreneurship, innovation systems, and business model theory converge to shape contemporary research agendas. Moreover, the temporal and density patterns reveal a shift from conceptual and normative discussions toward applied, impact-oriented, and ecosystem-level perspectives. This contributes to theory development by highlighting circular entrepreneurship as a dynamic, multi-level phenomenon that bridges environmental objectives with value creation, stakeholder engagement, and systemic change.

c. Limitations and Future Research Directions

Despite its contributions, this study has several limitations that should be acknowledged. First, the analysis is based on a single bibliographic database, which may exclude relevant publications indexed elsewhere or written in languages other than English. Second, science-mapping techniques rely on keyword selection and threshold settings, which can influence cluster formation and thematic visibility. As such, the results reflect dominant patterns of scholarly attention rather than the full diversity or practical effectiveness of circular entrepreneurship initiatives. Future research could address these limitations by incorporating multiple databases, applying mixed-method approaches, or complementing bibliometric findings with qualitative reviews and empirical case studies. Such efforts would deepen understanding of how circular entrepreneurship operates in different institutional and geographic contexts, and how it

contributes to sustainability transitions in practice.

4. CONCLUSIONS

This study provides a comprehensive overview of the evolution and scientific frontier of circular entrepreneurship research between 2015 and 2025 by systematically mapping its intellectual foundations, thematic structures, and emerging knowledge dynamics. The findings reveal that circular entrepreneurship has developed as an integrative research domain, anchored by the circular economy concept and increasingly shaped by entrepreneurial innovation, sustainability-oriented business models, and environmental impact considerations. The convergence of these themes indicates a maturation of the field, with scholarly attention shifting from conceptual framing toward applied, ecosystem-based, and impact-driven perspectives. The study highlights the growing coherence and interdisciplinary nature of circular entrepreneurship research, while also identifying emerging directions that offer a robust foundation for future theoretical advancement and practical implementation in support of sustainability transitions.

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