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Mapping the entrepreneurship ecosystem scholarship: current state and future directions

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Abstract

The relevance of entrepreneurial ecosystems in fostering economic growth has led to a recent surge in scholarship on the topic. We investigate the literature to provide researchers with a bird's-eye view extant entrepreneurial ecosystem research, with the goal of communicating the nature of the field and opportunities it presents. Specifically, we analyze 380 articles extracted from the Scopus database to reveal the structure of entrepreneurial ecosystem knowledge and determine the top contributors (authors, institutions, countries, journals, and articles). We identify key knowledge clusters and influential articles through methods including the cooccurrence of author's keywords and PageRank analysis. The four identified knowledge clusters are: (1) configuration and crucial dimensions of entrepreneurial ecosystems, (2) entrepreneurship for sustainability and circular economy, (3) building an innovation-driven ecosystem, and (4) knowledge, technology, and commercialization. Finally, we advise aspiring researchers in the entrepreneurship arena to explore the numerous avenues into which they may invest their efforts.

Keywords Entrepreneurship · Entrepreneurial ecosystem · Bibliometric analysis · Systematic literature review

Introduction

A culturally significant term with a great deal of associated meaning, 'entrepreneur' describes someone who starts and/or invests in one or more businesses while taking up the lion's share of the risks and rewards (Battisti et al., 2022). Over the years, scholars have devoted considerable effort to understanding individual entrepreneurs and venture teams, including their traits, attitudes, and economic impact. While acknowledging the significance of these endeavors, scholars have recently redirected their focus towards the specific circumstances in which entrepreneurs function, encompassing economic, social, and legal aspects of their work (Harima

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et al., 2021; Korber et al., 2022). This context hinders or helps their pursuit of viable opportunities particularly the economic and social environment in which they spring up (Dabić et al., 2023; Komlósi et al., 2022; Troise et al., 2024).

Scholars coined the term "entrepreneurial ecosystem" to describe this environment (Cohen, 2006; Mack & Mayer, 2016; Pitelis, 2012), in addition to other terms used in ecosystems research (e.g., regional entrepreneurship). Spigel (2022) defines an entrepreneurial ecosystem as "a set of independent actors and factors coordinated in such a way that they enable productive entrepreneurship within a particular territory" (p. 5). To expand on this definition, scholars have sought greater insight by studying related phenomena, such as the contexts in which a network of entities interacts and how synergies between them stimulate conditions for entrepreneurial success (Cloutier & Messeghem, 2022; Schou & Adarkwah, 2023). Formally defined, an entrepreneurial ecosystem is a group of interconnected elements in a given region—including people, organizations, and funding institutions, as well as the economic, ideological, and political climate—that function together to foster an environment, to a varied extent conducive or harmful, to the emergence and success of entrepreneurship (Merguei & Costa, 2022; Nylund et al., 2022; Proksch et al., 2024). Given the importance of ecosystems in driving entrepreneurship and growth, there are unsurprisingly a large number of articles on this issue.

However, despite this level of research, scholars have been skeptical about the nature of ecosystems research, with some wondering whether entrepreneurial ecosystem is nothing more than a fad (Wurth et al., 2022). This skepticism is due to several factors. First, there is a strong claim that ecosystems are nothing more than a buzzword, with policy implementation for outpacing research (Autio et al., 2018). This is especially evident in the realm of regulatory authorities promoting business innovation, where there is a focus on organizations adopting and utilizing digital capabilities. Second, ecosystems research is a combination of multiple fields, with differing paradigms, clouding the research with loose definitions and fluid concepts. Third, there is a lack of reliable statistical research on entrepreneurial ecosystems, as much of the research data is anecdotal and paradigmatic, such as case studies involving Silicon Valley.

To address these limitations, scholars need to systematically explore the extant literature, in order to take stock of the current body of work and to understand how research topics developed. Anchored in this analysis, we then seek to expand the research by exploring ways to build the supportive dynamics of entrepreneurial ecosystems. Although there have been several literature reviews of entrepreneurial ecosystems published, it should be noted that they have numerous limitations. To begin with, the majority of these research inquiries are generic and non-systematic (Cavallo et al., 2019; Mohammadi & Karimi, 2022), and they confine their inquiry to certain facets of ecosystems (Calabuig-Moreno et al., 2021; Robertson et al., 2020), signaling that future research should employ a different investigative strategy to generalize the results or gain new insight (Robertson et al., 2020; Theodoraki et al., 2022).

Likewise, a majority of these reviews also do not consider the procedures for conducting systematic reviews, such as PRISMA (Page et al., 2021) and SPAR-4-SLR (Paul et al., 2021), which offer us the opportunity to do a more systematic and organized review re-examination on the topic. PRISMA (Preferred Reporting Items

for Systematic Reviews and Meta-Analyses) is a methodology designed to enhance transparency and completeness in reporting systematic reviews. It provides a customizable framework, including a checklist and flow diagram, that guides researchers in documenting the stages of their literature search across multiple resources, ensuring comprehensive and clear reporting (Page et al., 2021). SPAR-4-SLR (Structured Protocol for Applying Relevance in Systematic Literature Reviews) provides a structured protocol that guides authors in systematically addressing the 'what,' 'why,' 'when,' 'where,' 'who,' and 'how' aspects of literature reviews, thereby offering direction and support in the systematic examination of literatures (Paul et al., 2021). When used in conjunction with bibliometric analysis, the systematic review approach provides comprehensive and justified interpretation that goes beyond what prior unstructured reviews could provide. Given the deficiencies of previous reviews on entrepreneurial ecosystems, this study is positioned to better map the domain using a technology-enabled systematic review, with the objective of obtaining answers to the research questions (RQs) listed below.

RQ1. *Who (or which) are the most noteworthy and significant contributors to entrepreneurial ecosystem research (e.g., journals, publications, authors, institutes, countries)?*
RQ2. *What are the various knowledge clusters that constitute prior research on the entrepreneurial ecosystem?*
RQ3. *What are the suggestions for advancing the knowledge of the entrepreneurial ecosystem?*

The remainder of the article is organized as follows. We first outline the data derivatization from the Scopus database as well as the analysis strategy to be employed in this review investigation. Then, we highlight and illustrate the findings of the analysis employed to address RQ1. We also summarize the findings of the analysis used to address RQ2. Finally, before concluding, we address RQ3, which provides a glance at potentially promising future research areas.

Literature review

The idea of the entrepreneurial ecosystem has left footprints within the literature of academics, policy makers, and the popular business press (Spigel, 2017). Basically, the idea of an entrepreneurial ecosystem refers to the "conditions that make ecosystems more or less favorable for entrepreneurship activity" (Liguori et al., 2019, p. 8). The appeal of the concept is intuitive: all companies benefit in some way from outside supporters that have provided resources in launching and sustaining the company (see Clausen & Molden, 2024, for a discussion on sourcing resources from ecosystems). These supporters have included early employees, government officials, mentors, customers, investors, and many others. The resources they have had provided include both rival resources (e.g., human and financial capital) or non-rivalrous resources (e.g., knowledge). Scholarly and entrepreneurs' recognition of the importance of this environment to venture success (or failure) has led to the

establishment of entrepreneurial ecosystem research and policy. Furthermore, this ecosystem not only offers competitive resources like capital, but it also serves as a fertile environment for non-competitive resources such as knowledge (Long et al., 2019; Xie et al., 2021). The sharing of ideas, experiences, and expertise serves as the collaborative catalyst that drives the entire system forward without competition (Cho et al., 2022). The intuitive appeal of this concept lies in its recognition that no venture exists in isolation (Merguei & Costa, 2022). It is not just about the survival of the fittest entrepreneur; it is about creating an environment where innovation can thrive, and success becomes a shared journey (Hayter et al., 2022; Muldoon et al., 2023; Walsh et al., 2021). The acknowledgment of the entrepreneurial ecosystem's pivotal role has rightfully led to increased scholarly and venture focus, creating a bridge between theory and practical policy implementations.

The conceptual history of the entrepreneurial ecosystem is long and complex. Its genesis comes from economics, especially the economics of Marshall (Autio et al., 2018; Marshall, 1920), in that it focuses on the relationship between a geographic region and economic growth. As such, it borrows from a wide range of fields and concepts, from regional clusters to innovation systems and urban economics. However, entrepreneurial ecosystems researchers have expanded beyond their original focus (which largely centered on manufacturing and multinational companies) to new venture growth. Research on entrepreneurial ecosystems is centered around four key components: (1) independent actors and factors, (2) coordination among these elements, (3) facilitation of productive entrepreneurship, and (4) a focus within a specific territory (Spigel, 2022).

First, an ecosystem features entrepreneurs, investors, advisors, potential workers, governments, non-governmental organizations (NGOs) and other actors. While these actors are independent, each of them has an interdependence with each other that requires a degree of coordination. Indeed, a noteworthy example of such coordination is observed in how teams (or individuals) unite to support ventures financially, exemplified by crowdfunding initiatives (Troise et al., 2024). When these actors are effectively coordinated, they generate synergies that, in turn, spur economic growth. Second, within the ecosystem, there is an underlying assumption that entrepreneurs catalyze value creation that transcends individual gain, fostering economic enhancement within the community at large. This contrasts with unproductive entrepreneurship, which yields benefits solely for the entrepreneur, such as rent-seeking activities.

Third, a key factor to consider is the adaptability of entrepreneurial ecosystems. Over time, these ecosystems have shown a remarkable ability to evolve in accordance with shifting economic, technological, and social circumstances (Scaringella & Radziwon, 2018; Thompson et al., 2018). The original emphasis on a multinational approach driven by entrepreneurship has expanded to include a broader spectrum of sectors, such as the growing arena of technology startups, social enterprises, and other innovative ventures (Cavallo et al., 2019; Cho et al., 2022). Last, while a well-defined geographic region, such as a city or country, remains a focal point, the interconnectedness facilitated by digital technologies allows for cross-border collaborations and the emergence of virtual entrepreneurial communities (Galappaththi et al., 2017). Additionally, the emphasis on productive

entrepreneurship underscores the importance of creating value not just for individual entrepreneurs but for the broader community. This aligns with a more sustainable and inclusive approach to economic development, where the benefits of entrepreneurial activities are distributed more equitably.

Growing attention to the entrepreneurial ecosystem's framework has encouraged scholars to create literature reviews (both systematic and traditional) in order to map the field. Before we begin our investigation, we must first determine if analogous research inquiries have been undertaken in the past, and Table 1 highlights such studies that were identified. We believe that there is a need to systemize our knowledge of entrepreneurial ecosystems, which rises in tandem with the number of research reviews on the topic, because these studies have several methodological limitations, as illustrated in Table 1.

Methodology

This review was motivated by the many other reviews already available that emphasized the need of using a systematic literature review methodology (cf., Kumar et al., 2022; Rao et al., 2023; Sahoo et al., 2023). According to these recently published reviews, an established review approach known as the Scientific Procedures and Rationales for Systematic Literature Reviews (SPAR-4-SLR) protocol devised by Paul et al. (2021) is gaining a great deal of traction in the business management arena. We draw methodological inspiration from these previous reviews and seek to examine a scholarly reservoir focusing on the entrepreneurial ecosystem by following the three-stage process of assembling, arranging, and assessing suggested by the SPAR-4-SLR guidelines. The SPAR-4-SLR is a methodology that focuses on conducting systematic literature reviews in a structured yet flexible approach, with an emphasis on qualitative synthesis of existing literature (Paul et al., 2021). In contrast, bibliometric analysis is a quantitative method that analyzes patterns and trends within a collection of bibliographic data, providing insights into the scholarly impact and interconnections of publications but without the qualitative aspect emphasized by SPAR-4-SLR. The SPAR-4-SLR guidelines support qualitatively narrowing down domain-specific studies that are more pertinent to researchers in the same field (Paul et al., 2021). As displayed in the schematic illustration of the SPAR-4-SLR methodology in Fig. 1, this review adhered to this methodology.

Assembling

In the first stage, coined "assembling," we find, collect, and filter the pertinent research. Assembling is subdivided into two stages: identification and acquisition (Paul et al., 2021). For the suggested methodological design to be carried out successfully, it is necessary to first complete the "identification" substage, in which we design the means to find pertinent research articles. The key emphasis of the identification phase was on selecting keywords specific enough to entrepreneurial ecosystems to capture all relevant prior studies. Following multiple forward and reverse

Table 1 Summary of prior reviews on entrepreneurial ecosystems

Research Group	No. of Paper Reviewed	Database	Time Period	Search Keyword, Review Approach, & Limitation
Cavallo et al. (2019)	118 Articles	Scopus	1973–2017	• Articles having keywords "entrep* ecosystem" and "entrep* system". • A descriptive summary was presented after qualitatively assessing the content of articles in the review corpus. • The review lacks identification of knowledge clusters through science mapping techniques and does not provide visual analysis.
Robertson et al. (2020)	431 Articles	Web of Science	1995–2019	• Articles containing the keyword "entrepreneurial ecosystem*," with an emphasis on the public sector. • The study is primarily a bibliographical review work, with emphasis on the most important authors, articles, journals, institutions, and countries. • The review lacks identification of knowledge clusters through science mapping techniques. In addition, the review does not provide future research directions. • The research team suggests that future studies incorporate quartile screening of articles in the review corpus, i.e., conducting analysis utilizing relevant articles published in high impact-factor journals.
Mohammadi and Karimi (2022)	765 Articles	Web of Science	1993–2020	• Articles having keywords ("startup" or "start-up" or "entrepreneur") and ("ecosystem*" or "environment*) not "cultural ecosystem services") • The review includes articles, conference proceedings, and book chapters. • The review identifies major knowledge clusters, yet fails to recommend avenues for further investigation.
Calabuig-Moreno et al. (2021)	31 Articles	Web of Science	2015–2019	• Articles containing the keywords sport*, ("knowledge" and "spillover*") and ("entrepreneur*" and "ecosystem*"), with a focus on the sports field. • The review is limited by its narrow scope of investigation, which solely considers the sports field. • Recommendation to re-evaluate the conducted search using the Scopus Database or Google Scholar.

Table 1 (continued)

Research Group	No. of Paper Reviewed	Database	Time Period	Search Keyword, Review Approach, & Limitation
Theodoraki et al. (2022)	119 Articles	Scopus	2006–2021	• Articles containing the keywords "entrepreneur* ecosystem*", with the search option confined to "Article Title". • The review considers quality screening for inclusion in the review corpus, as recommended by the chartered association of business schools (CABS) academic journal guide. • Articles published between the category 4* and category 2 are considered for inclusion. • The review is limited by its restricted scope of investigation, which considers solely "article title" for reflecting the results of keywords entered in query box of database, which may have excluded some potentially relevant articles on the topic of interest.

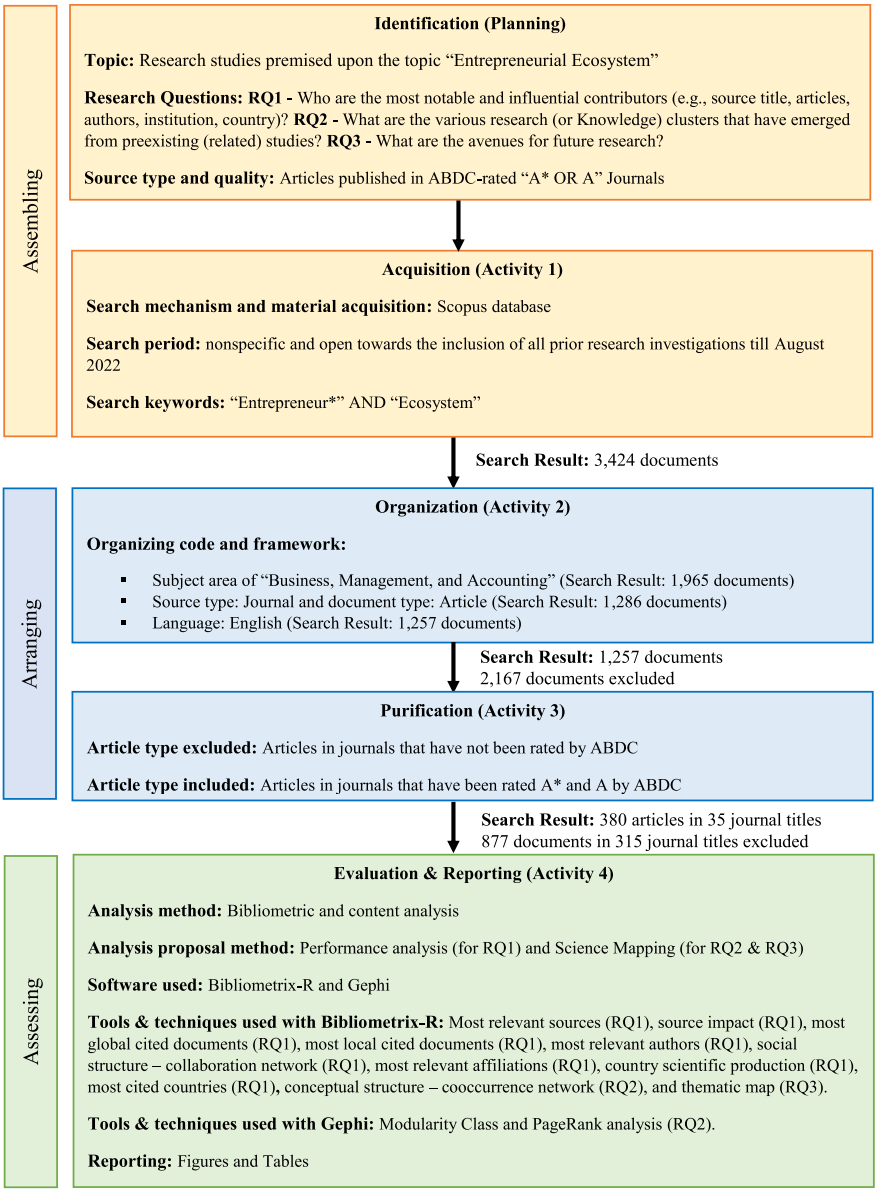

Fig. 1 Research design of literature review

searches, as well as an abstract screening process, the suitable keywords were found as "entrepreneur*" and "ecosystem". The research team decided on using Scopus as the preferred repository for literature analysis since it has more journals than other options like Web of Science (Ledro et al., 2022; Varma et al., 2022). Additionally, Scopus indexes most of the journals included in the Web of Science database (Singh

et al., 2021; Thelwall, 2018). We also filtered out articles based on several criteria, such as publication type, credibility and relevance, during the identification phase (Paul et al., 2021). Recent years have seen the rise of predatory journals as a widespread menace in the education community (Rice et al., 2021), so we performed a quality check on the journals included in our analysis. To do this, we drew inspiration from earlier research (Kumar et al., 2022; Mukhopadhyay et al., 2023; Sahoo et al., 2023) and used the Australian Business Dean Council's (ABDC) directory to identify top-quality journals with a strong track record of covering topics related to entrepreneurial ecosystems. The next screening phase, "acquisition," entails performing preliminary actions related to the search mechanism and acquiring literature centered on entrepreneurial ecosystem research (Fig. 1). Using the aforementioned search syntax in the Scopus Search Box on August 15, 2022, 3,424 documents were returned.

Arranging

Organization and purification are the two activity-based substages that make up the second stage, which is known as "arranging". Following the SPAR-4-SLR instructions (Paul et al., 2021), the 3,424 documents collected during the initial round must be sorted and cleaned in order to extract articles that pertain to the current study objectives. Setting the organizational code and framework necessary for extraction constitutes the organization activity. For this, we chose the subject area of "business, management, and accounting," used "journal" as the source type, "article" as the document type, and only included those published in English. There are strong reasons for these choices. In order to map the theoretical structure of entrepreneurial ecosystems research exclusively in the business management arena, the subject area of "business, management, and accounting" was first selected. When the search was run, it produced a result of 1,965 documents, excluding 1,459 documents from the first stage results. We chose the criterion of selecting source type as "journal" and document type as "article" because peer-reviewed journals have more stringent screening and inclusion standards than other types (Randolph et al., 2007), and because numerous prior studies supported screening of articles published in peer-reviewed journals (Mukhopadhyay et al., 2023; Prabhu & Srivastava, 2023). After excluding ineligible documents, such as books, editorials, conference proceedings, and notes, our search returned 1,286 documents. Then, we applied a "language" filter to standardize and improve the reliability of the current SLR, which further reduced the number of eligible articles to 1,257 documents.

Following organization is the "purification" sub-stage, which is predicated on the ABDC 2019 journal quality list (JQL). ABDC-JQL categorizes journals into four levels of quality (A*, A, B, and C), with A*- and A-rated journals representing excellent quality and B- and C-rated journals representing comparably reasonable quality. For the organization framework's concluding sub-stage activity, we only considered journals that were appraised by ABDC-JQL 2019 (Jaafar et al., 2021), taking into consideration the methodological approach of similar earlier research (Goyal & Kumar, 2021; Sahoo et al., 2023). This investigation turned up 380 articles that had been published in 35 credible publications, as per 2019 ABDC-JQL. Table 2 contains a descriptive summary of the retrieved review corpus of 380 articles.

Table 2 Quantitative summary of extracted review corpus

Frequency Range of Articles	Journal Title (No. of Articles, ABDC – Rating)
> 20 Articles	Small Business Economics (69, A); Technological Forecasting and Social Change (39, A); Entrepreneurship and Regional Development (25, A); Research Policy (25, A*); Journal of Business Research (24, A).
10–19 Articles	IEEE Transactions on Engineering Management (17, A); Journal of Business Venturing Insights (16, A); Technovation (15, A); Journal of Cleaner Production (12, A); Regional Studies (12, A*); Business Strategy and the Environment (10, A); Industrial and Corporate Change (10, A).
5–9 Articles	Knowledge Management Research and Practice (9, A); Environment and Planning A: Economy and Space (8, A*); Entrepreneurship Theory and Practice (7, A*); Journal of Environmental Management (7, A); Strategic Entrepreneurship Journal (7, A); Journal of Business Venturing (6, A*); Journal of Hospitality and Tourism Management (6, A); Journal of Small Business Management (6, A); Strategic Management Journal (5, A*); Studies in Higher Education (5, A).
2–4 Articles	California Management Review (4, A); Ecological Economics (4, A); International Journal of Information Management (4, A*); Marine Policy (4, A); Urban Studies (4, A*); Academy of Management Perspectives (3, A); Asia Pacific Journal of Management (3, A); Journal of Business and Industrial Marketing (3, A); Journal of International Management (3, A); Journal of Management Inquiry (3, A); Strategic Organization (3, A); Academy of Management Journal (2, A*).

Journal rating as per ABDC (i.e., Australian Business Dean Council 2019 Journal Quality List). Review corpus includes 9 A*-rated journals and 23 A-rated journals

Assessing

The third stage, termed "Assessing," consists of actions linked to analysis and reporting, with a major focus on analyzing bibliographic information and reporting the findings (Paul et al., 2021). To answer the study's three objectives (RQ1–RQ3), this review analyses 380 articles retrieved utilizing a bibliometric approach using a combination of performance analysis and science mapping analysis (Aria & Cuccurullo, 2017; Cobo et al., 2011; Donthu et al., 2021). Introspection on the role of diverse contributors in the research process is an essential component of any performance analysis (Chandra et al., 2022; Viglia et al., 2022), while science mapping aims to represent the links that exist between research constituents (Lim et al., 2022; Núñez-Merino et al., 2022). To address the proposed RQ1, Bibliometrix-R software was used to determine the most relevant journal (source title), most influential journal (source title), most impactful articles, most relevant authors, most relevant countries, and most impactful countries (Aria & Cuccurullo, 2017; Donthu et al., 2021). To answer the proposed RQ2, we next conducted a science mapping analysis with the Bibliometrix-R software (Aria & Cuccurullo, 2017), using the "cooccurrence network" tool to visualize the significant associations between authors' indexed keywords and map the thematic pattern (knowledge clusters) emerging from the review corpus. In addition, we utilized the page-analysis tool in Gephi software to identify significant research articles in each knowledge cluster (Bastian et al., 2009; Goyal & Kumar, 2021), triangulating these results with knowledge clusters produced using

Bibliometrix-R. The subsequent step included analyzing the research articles featured within each knowledge cluster using the method of content analysis. In order to suggest directions for further study in response to RQ3, we employed the "thematic map" technique to analyze the quantity and prominence of topics and distinguish between basic, motor, niche, and emerging ones. In aspects of results reporting (Donthu et al., 2021; Moral-Munoz et al., 2019), this research follows in the footsteps of previous systematic reviews by presenting its results (convention) using a mix of figures (network visualization), tables (bibliometrics), and words (accompanying narratives). We note that findings our review, like many of its similar prior studies (Goyal et al., 2021; Lim et al., 2022; Mukhopadhyay et al., 2023), may be limited by the accuracy and breadth of the bibliometric data available via Scopus and the scope of what can be accomplished by a systematic literature review.

Results: performance analysis

Publication trend (RQ1)

Figure 2 depicts the distribution of publications by year of publication, which demonstrates that academic interest in the research of entrepreneurial ecosystems has been steadily growing over the last three decades. The second stage of the extraction process uncovered a total of 380 articles related to the topic of entrepreneurial ecosystems; the first two of them (Bahrami & Evans, 1995; Cohen, 2006) appeared in 1995 and 2006, respectively. Figure 2 indicates that annual publishing trends stayed in the single digits from 1995 to 2015, then soared into the double digits starting in 2016. There was a significant increase in publications in 2021, with 100 publications, reflecting a 100% increase over the previous year (i.e., 2020).

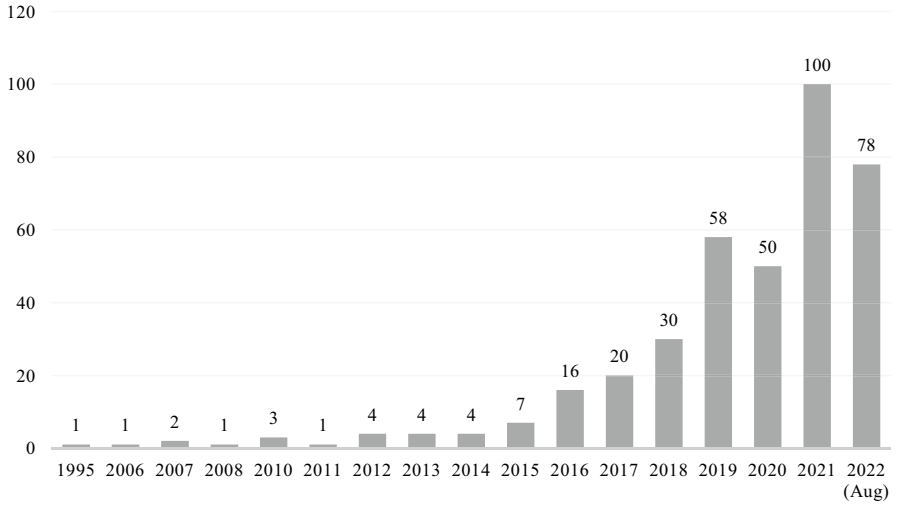

Fig. 2 Publishing trends in entrepreneurial ecosystem research

Performance of source title (RQ1)

Table 2 shows the breakdown of articles by journal source, with *Small Business Economics* (with 69 articles) clearly standing out as the top choice for research on entrepreneurial ecosystems. This is followed by 39 articles in *Technological Forecasting and Social Change* and 25 articles in *Entrepreneurship and Regional Development*, which place them second and third in the source title category, respectively. According to Table 3, when evaluating journals based on total citations (TC) and h-index, *Strategic Management Journal* ranks first with 6,106 citations from five

Table 3 High-impact journal titles in entrepreneurial ecosystem research

Journal Title	TC	TP	Start PY	h-index
Strategic Management Journal	6,106	5	2007	4
Small Business Economics	3,431	69	2015	30
Technological Forecasting and Social Change	1,390	39	2016	20
Research Policy	1,154	25	2008	10
Strategic Entrepreneurship Journal	1,119	7	2018	7
Entrepreneurship: Theory and Practice	1,114	7	2013	5
Journal of Business Venturing Insights	614	16	2017	9
Business Strategy and the Environment	604	10	2006	6
Entrepreneurship and Regional Development	567	25	2011	12
Journal of Business Research	527	24	2013	8
Journal of Cleaner Production	405	12	2016	10
California Management Review	332	4	1995	4
Industrial and Corporate Change	314	10	2012	8
Urban Studies	260	4	2016	3
Technovation	236	15	2014	7
Strategic Organization	214	3	2013	1
Regional Studies	207	12	2016	7
Ecological Economics	203	4	2007	4
Journal of Environmental Management	143	7	2010	6
Marine Policy	136	4	2013	4
Academy of Management Perspectives	118	3	2016	2
Environmental and Planning A: Economy and Space	104	8	2015	7
Journal of Hospitality and Tourism Management	91	6	2019	6
IEEE Transactions of Engineering Management	87	17	2019	6
Knowledge Management Research and Practice	66	9	2021	5
Journal of Business Venturing	66	6	2019	4
Academy of Management Journal	65	2	2018	2
Asia Pacific Journal of Management	54	3	2017	3
International Journal of Information Management	49	4	2016	3
Journal of International Management	48	3	2015	3
Journal of Management Inquiry	32	2	2019	3
Journal of Small Business Management	32	6	2018	2
Studies in Higher Education	22	5	2020	2

TC Total Citations, *TP* Total Publication, *PY* Publication Year

articles and an h-index of four. The h-index is the maximum value of h such that the given journal has published at least h articles, each of which has been cited by at least h times, and is used as a measure of the productivity and citation impact of publications linked with the journal title (Bornmann & Daniel, 2007). As seen from the Table 3, *Small Business Economics* (TC = 3,431) and *Technological Forecasting and Social Change* (TC = 1,390) are second and third on the list based on total citations. Furthermore, when the h-index is utilized as the criterion for ranking, *Small Business Economics* (h-index = 30), *Technological Forecasting and Social Change* (h-index = 20), and *Entrepreneurship and Regional Development* (h-index = 12) are the top three journals.

Performance of article (RQ1)

Global citations When searching for citations to an article in Scopus, the total global citation (TGC) count is the total number of citations found for that article regardless of what filters (such as subject, year, source etc.) were used (Donthu et al., 2021; Kumar et al., 2021, 2022). The article with the most global citations in this review corpus of 380 articles, as shown in Table 4, is "*Explicating dynamic capabilities: The nature and microfoundations of (sustainable) enterprise performance*" (TGC = 5,869 citations), followed by "*The relational organization of entrepreneurial ecosystems*" (TGC = 720 citations). The top 20 global cited articles list in Table 4 shows five occurrences of articles published in "*Small Business Economics*" and two occurrences of articles published in "*Strategic Management Journal*", "*Strategic Entrepreneurship Journal*", and "*Business Strategy and the Environment*."

Local citations Table 5 depicts the top articles in the review corpus, presented in increasing order of their ranking in the list based on the total local citation (TLC) metric (Donthu et al., 2021), which displays the number of citations in each article's reference list to other articles in the review corpus of 380 articles. With 111 citations, the article titled "*The relational organization of entrepreneurial ecosystems*" received the most TLC, followed by the article titled "*Entrepreneurial innovation: The importance of context*" with 75 local citations. Table 5 further demonstrates that the journal "*Small Business Economics*" covers eight of the top 20 locally cited articles.

Author performance (RQ1)

Leading authors Figure 3 displays the top 20 contributing authors sorted by the number of publications contributed to entrepreneurial ecosystems research. David B. Audretsch, who is presently associated with Indiana University, is at the top of the list with ten articles. These ten articles have appeared in four journals, with the majority of them (seven articles) appearing in *Small Business Economics* and one article each in *IEEE Transactions on Engineering Management*, *Journal of Small Business Management*, and *Regional Studies*. Bruno B. Fischer (University of Campinas) and Maribel Guerrero (Arizona State University) both rank second on

Table 4 Top 20 global cited articles in entrepreneurial ecosystem research

Article Title	Author (s)	Year	Journal Title	TGC
Explicating dynamic capabilities: The nature and microfoundations of (sustainable) enterprise performance	D.J. Teece.	2007	Strategic Management Journal	5,869
The relational organization of entrepreneurial ecosystems	B. Spigel.	2017	Entrepreneurship: Theory and Practice	720
Entrepreneurial innovation: The importance of context	E. Autio, M. Kenney, P. Mustar, D. Siegel, and M. Wright.	2014	Research Policy	624
Digital affordances, spatial affordances, and the genesis of entrepreneurial ecosystems	E. Autio, S. Nambisan, L.D.W. Thomas, and M. Wright.	2018	Strategic Entrepreneurship Journal	392
The lineages of the entrepreneurial ecosystem approach	Z.J. Acs, E. Stam, D.B. Audretsch, and A. O'Connor.	2017	Small Business Economics	351
Sustainable valley entrepreneurial ecosystems	B. Cohen.	2006	Business Strategy and the Environment	348
Startups in times of crisis – A rapid response to the COVID-19 pandemic	A. Kuckertz, L. Brändle, A. Gaudig, S. Hinderer, C.A.M. Morales, A. Prochotta, K.M. Steinbrink, and E.S.C Berger.	2020	Journal of Business Venturing Insights	332
Toward a process theory of entrepreneurial ecosystems	B. Spigel and R. Harrison.	2018	Strategic Entrepreneurship Journal	299
Entrepreneurship in innovation ecosystems: Entrepreneurs' self-regulatory processes and their implications for new venture success	S. Nambisan and R.A. Baron.	2013	Entrepreneurship: Theory and Practice	279
Looking inside the spiky bits: a critical review and conceptualisation of entrepreneurial ecosystems	R. Brown and C. Mason.	2017	Small Business Economics	273
The digital entrepreneurial ecosystem	F. Sussan and Z.J. Acs.	2017	Small Business Economics	247
The evolutionary dynamics of entrepreneurial ecosystems	E. Mack and H. Mayer.	2016	Urban Studies	241
The business model: A theoretically anchored robust construct for strategic analysis	C. Zott, and R. Amit.	2013	Strategic Organization	214

Table 4 (continued)

Article Title	Author (s)	Year	Journal Title	TGC
Unpacking the innovation ecosystem construct: Evolution, gaps and trends	L.A.D.V. Gomes, A.L.F. Facin, M.S. Salerno, and R.K. Ikenami.	2018	Technological Forecasting and Social Change	211
Flexible Re-Cycling and High-Technology Entrepreneurship	H. Bahrami and S. Evans.	1995	California Management Review	207
The disruptor's dilemma: TiVo and the U.S. television ecosystem	S.S Ansari, R. Garud, and A. Kumaraswamy.	2016	Strategic Management Journal	193
Entrepreneurship, institutional economics, and economic growth: an ecosystem perspective	Z.J. Acs, S. Estrin, T. Mickiewicz, and L. Szerb.	2018	Small Business Economics	184
The emergence of entrepreneurial ecosystems: A complex adaptive systems approach	P.T. Roundy, M. Bradshaw, and B.K. Brockman.	2018	Journal of Business Research	184
Entrepreneurial universities: emerging models in the new social and economic landscape	M. Guerrero, D. Urbano, A. Fayolle, M. Klofsten, and S. Mian.	2016	Small Business Economics	174
Commitment to Sustainability in Small and Medium-Sized Enterprises: The Influence of Strategic Orientations and Management Values	J. Jansson, J. Nilsson, F. Modig, and G. Hed Vall.	2017	Business Strategy and the Environment	172

TGC Total Global Citations

Table 5 Top 20 local cited articles in entrepreneurial ecosystem research

Article Title	Author (s)	Year	Journal Title	TLC
The relational organization of entrepreneurial ecosystems	B. Spigel.	2017	Entrepreneurship: Theory and Practice	111
Entrepreneurial innovation: The importance of context	E. Autio, M. Kenney, P. Mustar, D. Siegel, and M. Wright.	2014	Research Policy	75
The lineages of the entrepreneurial ecosystem approach	Z.J. Acs, E. Stam, D.B. Audretsch, and A. O'Connor.	2017	Small Business Economics	74
Digital affordances, spatial affordances, and the genesis of entrepreneurial ecosystems	E. Autio, S. Nambisan, L.D.W. Thomas, and M. Wright.	2018	Strategic Entrepreneurship Journal	56
Looking inside the spiky bits: a critical review and conceptualisation of entrepreneurial ecosystems	R. Brown and C. Mason.	2017	Small Business Economics	56
Toward a process theory of entrepreneurial ecosystems	B. Spigel and R. Harrison	2018	Strategic Entrepreneurship Journal	54
Sustainable valley entrepreneurial ecosystems	B. Cohen.	2006	Business Strategy and the Environment	54
The evolutionary dynamics of entrepreneurial ecosystems	E. Mack and H. Mayer.	2016	Urban Studies	47
The emergence of entrepreneurial ecosystems: A complex adaptive systems approach	P.T. Roundy, M. Bradshaw, and B.K. Brockman.	2018	Journal of Business Research	35
Entrepreneurship in innovation ecosystems: Entrepreneurs' self-regulatory processes and their implications for new venture success	S. Nambisan and R.A. Baron.	2013	Entrepreneurship: Theory and Practice	32
The resilience of entrepreneurial ecosystems	P.T. Roundy, B.K. Brockman, and M. Bradshaw.	2017	Journal of Business Venturing Insights	29
The digital entrepreneurial ecosystem	F. Sussan and Z. J. Acs	2017	Small Business Economics	29
Accelerator expertise: Understanding the intermediary role of accelerators in the development of the Bangalore entrepreneurial ecosystem	K. Goswami, J.R. Mitchell, and S. Bhagavatula.	2018	Strategic Entrepreneurship Journal	27
How entrepreneurial ecosystems take form: Evidence from social impact initiatives in Seattle	T.A. Thompson, J.M. Purdy, and M.J. Ventresca.	2018	Strategic Entrepreneurship Journal	26
The adaptive life cycle of entrepreneurial ecosystems: the biotechnology cluster	P.E. Auerswald and L. Dani.	2017	Small Business Economics	25

Table 5 (continued)

Article Title	Author (s)	Year	Journal Title	TLC
Clusters, entrepreneurial ecosystem co-creation, and appropriability: a conceptual framework	C. Pitelis.	2012	Industrial and Corporate Change	25
A social capital approach to the development of sustainable entrepreneurial ecosystems: an explorative study	C. Theodoraki, K. Messeghem & M.P. Rice.	2018	Small Business Economics	20
Entrepreneurship, institutional economics, and economic growth: an ecosystem perspective	Z.J. Acs, S. Estrin, T. Mickiewicz, and L. Szerb.	2018	Small Business Economics	19
Searching for the existence of entrepreneurial ecosystems: a regional cross-section growth regression approach	K. Bruns, N. Bosma, M. Sanders, and M. Schramm.	2017	Small Business Economics	19
The campus as entrepreneurial ecosystem: the University of Chicago	D.J. Miller and Z.J. Acs	2017	Small Business Economics	18
Explicating dynamic capabilities: The nature and microfoundations of (sustainable) enterprise performance	D.J. Teece.	2007	Strategic Management Journal	18

TLC Total Local Citations

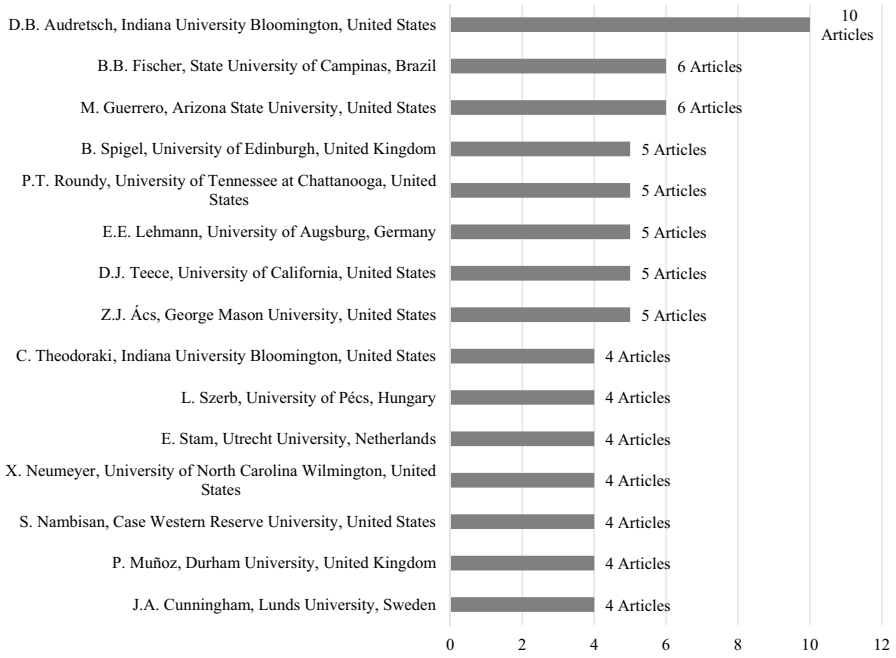

Fig. 3 Top contributing authors in entrepreneurial ecosystem research

the list of top contributing authors, with six articles to their credit. Next on the list of top contributing authors with five articles to their credit are five authors, who are Ben Spigel (University of Edinburgh), Phillip T. Roundy (University of Tennessee at Chattanooga), Erik E. Lehmann (Augsburg University), David J. Teece (University of California, Berkeley), and Zoltan J. Acs (George Mason University).

However, results are different when listing the most influential authors based on the impact (i.e., total citations) in the field of research on entrepreneurial ecosystems (Table 6). David J. Teece, has received the most citations (TC = 5,909) for five articles published in four different journals: *Strategic Management Journal* (published in 2007), *Industrial and Corporate Change* (published in 2012 and 2019), *Academy of Management Perspectives* (published in 2016), and *Research Policy* (published 2022). Ben Spigel and Michael Wright are second and third on the list of influential authors, with 1,078 and 1,061 citations, respectively. However, when ranking authors based on the h-index criterion, David B. Audretsch is at the top of the list with an h-index of 6, followed by Zoltan J. Acs (h-index = 5), as provided in Table 6.

Leading author collaborations The "collaboration network" option, found under the social structure tab in the Bibliometrix-R package (Aria & Cuccurullo, 2017; Donthu et al., 2021), is a scientific mapping to identify noteworthy author collaborations that have transpired on a research topic. Figure 4 depicts the authorship network of prominent researchers who have worked together towards research on entrepreneurial ecosystems. The diameter of the circle (node) denotes the frequency

Table 6 Top 20 authors in entrepreneurial ecosystem research

Author	Current Affiliation	TP	PY-Start	TC	h-index
D.J. Teece	University of California Berkeley, United States	5	2007	5,909	3
B. Spigel	University of Edinburgh, United Kingdom	5	2017	1,078	4
M. Wright	Imperial College London, United Kingdom	4	2014	1,061	4
E. Autio	Imperial College London, United Kingdom	2	2014	1,016	2
Z.J. Acs	George Mason University, United States	5	2017	877	5
S. Nambisan	Case Western Reserve University, United States	4	2013	868	4
D. Siegel	Arizona State University, United States	4	2014	836	4
M. Kenney	University of California, United States	3	2014	826	3
P. Mustar	Paris School of Mines Research University, France	1	2014	624	1
E. Stam	Utrecht University, Netherlands	4	2017	559	4
A. Kuckertz	University of Hohenheim, Germany	3	2016	465	3
D.B. Audretsch	Indiana University Bloomington, United States	7	2017	442	6
E.S.C Berger	Johannes Kepler University Linz, Austria	2	2016	407	2
L.D.W Thomas	University of Navarra, Spain	1	2018	392	1
A. O'Connor	University of South Australia, Australia	2	2017	351	1
B. Cohen	EADA Business School, Spain	1	2006	346	1
L. Brändle	University of Hohenheim, Germany	1	2020	331	1
A. Gaudig	University of Hohenheim, Germany	1	2020	331	1
S. Hinderer	University of Hohenheim, Germany	1	2020	331	1
C.A. Morales Reyes	University of Hohenheim, Germany	1	2020	331	1
A. Prochotta	University of Hohenheim, Germany	1	2020	331	1
K.M. Steinbrink	University of Hohenheim, Germany	1	2020	331	1

TP Total Publication, *PY* Publication Year, *TC* Total Citations

of articles associated with the author, whilst the thickness of the lines connecting two nodes represents the frequency of collaboration between two authors (Aria & Cuccurullo, 2017). According to the results of the collaboration network analysis (Fig. 4), there are ten clusters of author collaboration that emerge. The strongest collaboration network appears to be between David B. Audretsch, Zoltan J. Acs, Erik E. Lehmann, and Laszlo Szerb (Red cluster; Fig. 4). Another powerful network of collaboration is between Philip T. Roundy, who is placed in the center of the network, and Mike Bradshaw and Beverly K. Brockman, who are located on the network's edges.

Institution performance (RQ1)

Figure 5 displays the frequency of articles published according to association with institutions, with Utrecht University (Netherlands) leading the list with 14 articles. Second on the list is Indiana University Bloomington (United States), with 13 articles, followed by University of Cambridge (United Kingdom), with ten articles. A

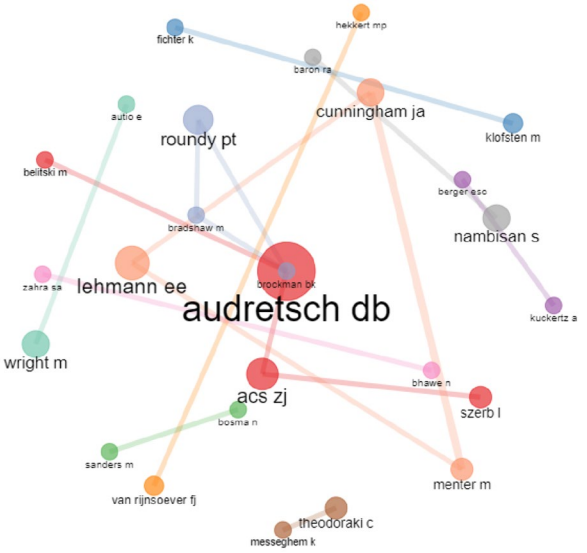

Fig. 4 Leading author's collaboration in entrepreneurial ecosystem research

secondary analysis of the institutional collaboration network produced three notable institutional collaboration networks (minimum two collaborations), which are: (1) Indiana University Bloomington (United States), George Mason University (United

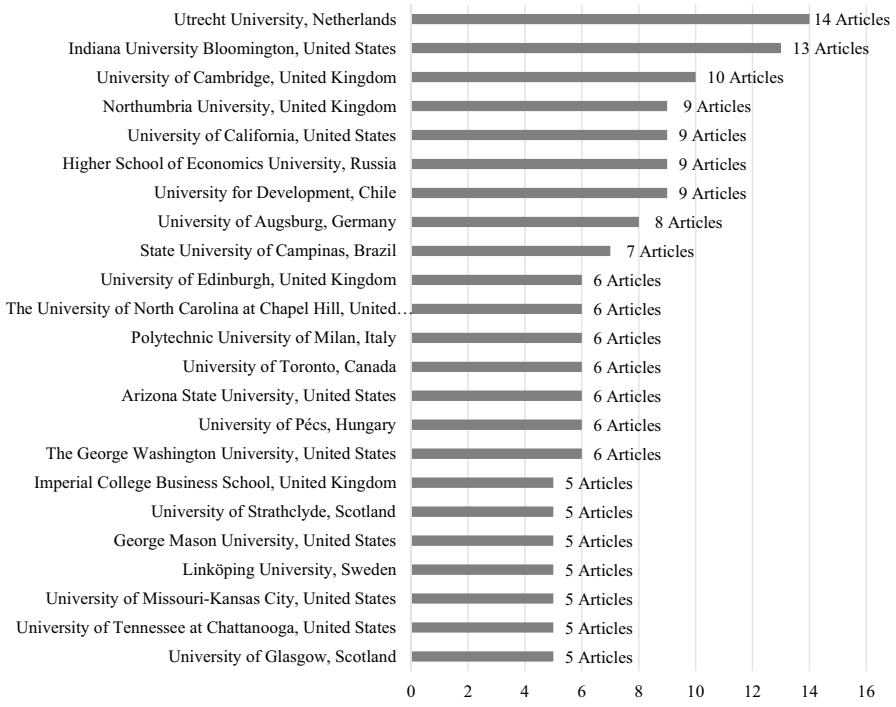

Fig. 5 Top contributing institutions in entrepreneurial ecosystem research

States), and University of Pécs (Hungary); (2) Northumbria University (United Kingdom) and University of Augsburg (Germany); (3) State University of Campinas (Brazil), University for Development (Chile), and George Washington University (United States).

Country performance (RQ1)

Figure 6 is a global heat map that shows the countries with the most significant contributions to the study of entrepreneurial ecosystems. The global heat map is an interactive tool for measuring the presence of a country affiliated with a certain article. The map's color ranges from deep blue to deep green to indicate, respectively, territories from a low density (0–20) to a high density (120–140) of published research. Looking at the global heat map (Fig. 6), it is clear that blue dominates the majority of the globe map, indicating that research on entrepreneurial ecosystem is sparse in most developing countries and requires greater academic attention. The majority of the countries marked in deep blue color, are from Asia, Africa, and South America. Light blue zones represent countries with a reasonable number of studies (20–40 articles) on entrepreneurial ecosystem, such as Canada, Australia, China, and several European countries. The United Kingdom is in the light-yellow zone with 89 articles and ranks second in terms of scholarly contribution, while the United States is in the deep green zone and tops the list with 137 articles. As a result, the United States, the United Kingdom, Germany, Sweden, and Italy accounted for the vast majority of the publications. This suggests that the level of research activity in countries with mature entrepreneurial ecosystems is indicative

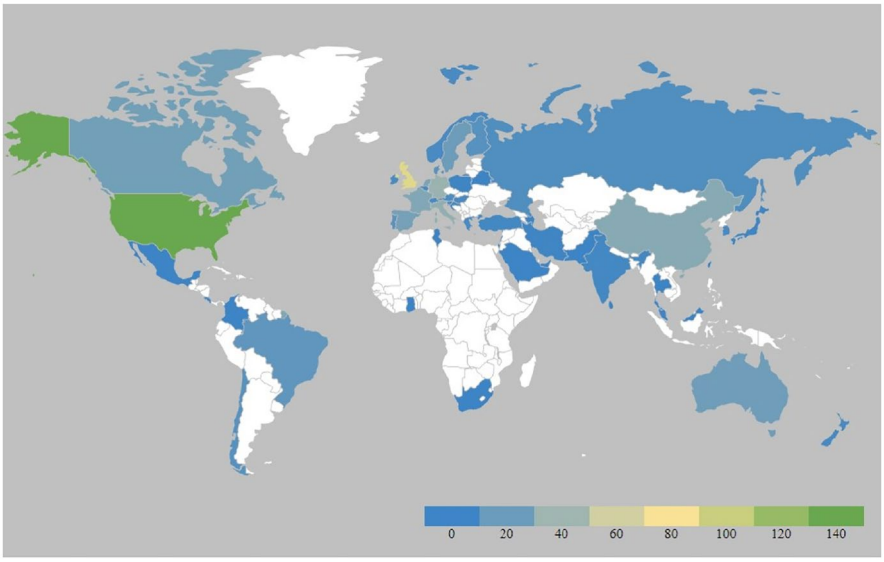

Fig. 6 Geographic heat map of countries reflecting their density in entrepreneurial ecosystem research. Note: Deep blue reflecting low density (0–20) and deep green reflecting high density (120–140)

of the nature of these ecosystems. Conversely, the low frequency of research in other countries (e.g., Costa Rica, Ghana, Pakistan, Sri Lanka, and Tunisia) may indicate that their research efforts are still in the early stages, which possibly reflects the nascent state of their entrepreneurial ecosystems. Alternatively, the scarcity of research might also be interpreted as indicative of author indifference.

Similarly, in terms of cross-country collaboration, the United States leads with 114 instances of collaboration with 28 countries, followed by the United Kingdom with 92 instances of collaboration with 28 countries. In a subsequent ranking based on the criteria of total citations, as shown in Fig. 7, the United States received the most citations with 8,725 citations, followed by the United Kingdom with 3,017 citations.

Results: science mapping

Knowledge cluster (RQ2)

To understand the interconnectedness between various themes of knowledge, articles, and researchers, we implemented science mapping which provides a pictorial depiction based on network analysis (Aria & Cuccurullo, 2017; Donthu et al., 2021; Moral-Munoz et al., 2019). One such method of scientific mapping is called cooccurrence network analysis of author's keyword, and it quantifies the frequency with which two keywords appear in a corpus of articles together in

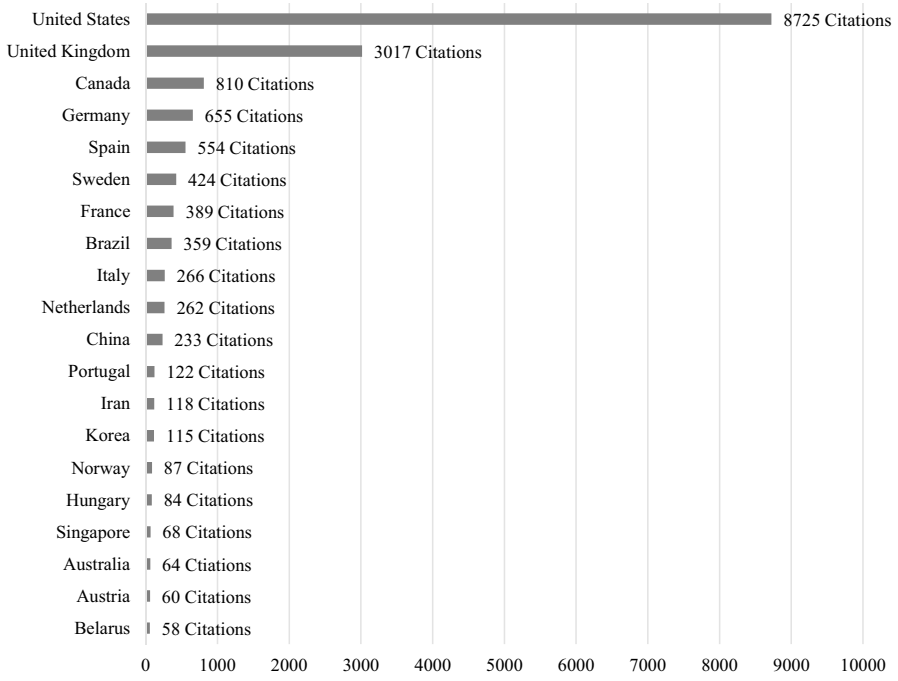

Fig. 7 Most impactful countries in entrepreneurial ecosystem research

a certain order beyond what would be expected by chance (Liu & Zhao, 2011). To do this, we utilized the cooccurrence network tool to classify the articles into knowledge clusters based on the authors' indexed keywords (Aria & Cuccurullo, 2017; Donthu et al., 2021). Using this method, we were able to identify four major knowledge clusters related to the study of entrepreneurial ecosystems, as shown in Fig. 8, which is a graphical representation of the network link between the author's indexed keywords. Every keyword in the extracted review corpus is represented by a node in the network map (Fig. 8), with the size of the node corresponding to the frequency with which it appears in the corpus (Khanra et al., 2022; Mohammadi & Karimi, 2022; Theodoraki et al., 2022). Only when two keywords cooccur do they seem connected by a line in the network map (Fig. 8), and the line's thickness varies with the frequency of occurrence; the thicker the line, the greater the cooccurrence, and vice versa (Aria & Cuccurullo, 2017; Ledro et al., 2022; Liu & Zhao, 2011). The proximity of two nodes indicates the closeness of their associated keywords, whereas a greater separation between them indicates that they are just tangentially linked (Kumar et al., 2022; Sahoo et al., 2023).

Three centrality factors—betweenness, closeness, and PageRank—are used to describe the four knowledge clusters identified by cooccurrence network analysis (shown in Fig. 8). These parameters are supplemented by the data in Table 7. A node's "betweenness" centrality reflects the degree to which other nodes rely on it and, by extension, the degree to which it might exert influence (Barthelemy, 2004; Gupta et al., 2022; Xu et al., 2022). The conventional interpretation of closeness centrality is either as a measure of access effectiveness or of independence from possible intermediary control (Coccia et al., 2022; Crescenzi et al., 2017; He et al.,

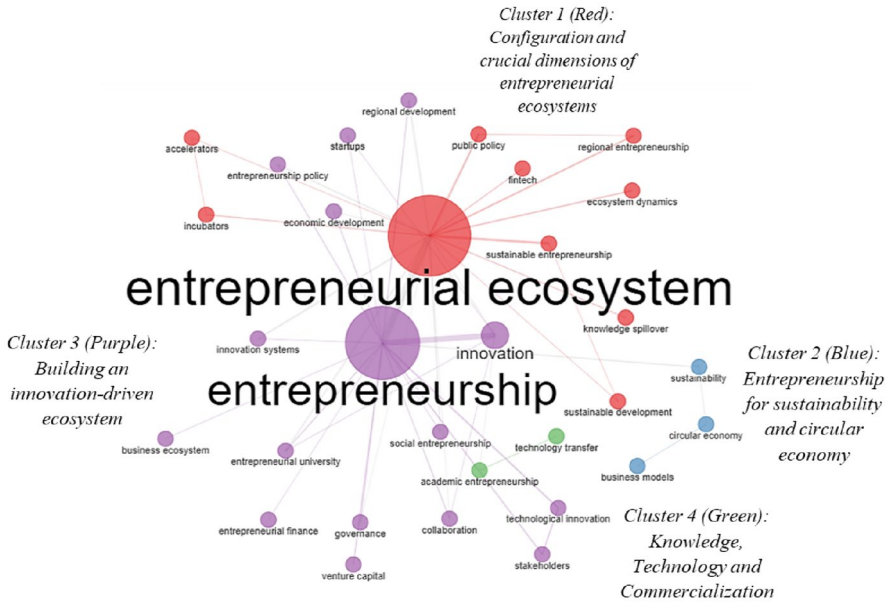

Fig. 8 Knowledge clusters in entrepreneurial ecosystem research

Table 7 Keywords of knowledge clusters in entrepreneurial ecosystem research

Node (Keyword)	Betweenness	Closeness	PageRank
Cluster 1: Configuration and crucial dimensions of entrepreneurial ecosystems			
Entrepreneurial Ecosystem	512.143	0.015	0.205
Sustainable Entrepreneurship	0.000	0.009	0.018
Public Policy	0.846	0.011	0.022
Knowledge Spillover	0.000	0.009	0.008
Regional Entrepreneurship	0.000	0.009	0.017
Fintech	0.000	0.009	0.008
Incubators	0.000	0.009	0.012
Sustainable Development	0.000	0.009	0.009
Accelerators	0.000	0.009	0.011
Ecosystem Dynamics	0.000	0.009	0.009
Cluster 2: Entrepreneurship for sustainability and circular economy			
Sustainability	86.00	0.010	0.019
Circular Economy	44.00	0.007	0.018
Business Models	0.000	0.005	0.009
Cluster 3: Building an innovation-driven ecosystem			
Entrepreneurship	604.331	0.016	0.207
Innovation	89.347	0.012	0.053
Social Entrepreneurship	0.000	0.011	0.013
Entrepreneurial University	3.325	0.011	0.021
Innovation Ecosystems	0.000	0.009	0.014
Governance	1.162	0.011	0.015
Regional Development	0.000	0.011	0.016
Technological Innovation	0.000	0.011	0.016
Collaborations	0.000	0.011	0.014
Entrepreneurship Policy	0.000	0.009	0.010
Innovation Systems	0.000	0.011	0.014
Business Ecosystems	0.000	0.009	0.010
Economic Development	0.000	0.011	0.011
Stakeholders	0.000	0.009	0.006
Entrepreneurial Finance	0.000	0.010	0.008
Startups	0.000	0.010	0.009
Cluster 4: Knowledge, technology, and commercialization			
Academic Entrepreneurship	44.00	0.008	0.016
Technology Transfer	0.000	0.006	0.011

2022). Lastly, "PageRank" centrality evaluates the significance of a node by calculating the number of in-links the node has in comparison to other important nodes, and by analyzing the cooccurring network structure of the author's keyword in the review corpus (Cobo et al., 2011; Leydesdorff, 2009).

Table 7 adds to the information shown in Fig. 8, which depicts a network of different colored nodes representing different knowledge clusters. Cluster 1 is shown in Fig. 8 as a constellation of red nodes, which contains major keywords based on PageRank scores (Table 7) such as "entrepreneurial ecosystem" (PageRank Score = 0.205), "public policy" (PageRank Score = 0.022), "sustainable entrepreneurship" (PageRank Score = 0.018), "regional entrepreneurship" (PageRank Score = 0.017), and "incubators" (PageRank Score = 0.012). This signifies that research in this cluster explored ecosystem topologies favorable to entrepreneurship, which includes subjects such as "knowledge spillover", "fintech", "sustainable development", "accelerators", and "ecosystem dynamics." We may infer that the configuration and crucial dimensions of entrepreneurial ecosystems are of interest to the scholarly representatives of this cluster.

Three keywords are found within Cluster 2, shown in Fig. 8 by a blue network of nodes: "sustainability", "circular economy", and "business models." The prominent keywords in the cluster are "sustainability" (PageRank Score = 0.019) and "circular economy" (PageRank Score = 0.018). Both betweenness and closeness centralities for these keywords are relatively substantial, supporting this finding. This suggests that the cluster places an emphasis on innovative research centered on sustainability and circular economy.

Cluster 3 is depicted by a purple network of 16 nodes, with keywords "entrepreneurship", "innovation", "entrepreneurial university", "regional development", and "technological innovation" prominently featured, with PageRank scores of 0.207, 0.053, 0.021, 0.016, and 0.016, respectively. Table 7 shows that the keywords "entrepreneurship", "innovation", "entrepreneurial university", and "governance" have betweenness centrality scores of 604.331, 89.347, 3.325, and 1.162, respectively; these scores indicate that these keywords co-occur frequently to form the central theme of the cluster along with other 12 keywords. In particular, the closeness centrality between 16 nodes (keywords) ranges from 0.009 to 0.016, indicating that the remaining 14 keywords are all linked to the "entrepreneurship" and "innovation" keywords (which have the highest closeness centrality of 0.016 and 0.012, respectively). All of these keywords converge towards the concept of developing an innovation driven environment.

Finally, Cluster 4, made up of two green nodes - "academic entrepreneurship" and "technology transfer" - forms the conceptual cluster of knowledge, technology, and commercialization. Within the cluster, the keyword "academic entrepreneurship" has the greatest PageRank (0.016), betweenness (44.00), and closeness (0.008) scores.

After identifying four knowledge clusters using cooccurrence network analysis, we triangulated the results using Gephi, where we used network analysis to classify content into modularity classes (i.e., knowledge clusters) and calculate the PageRank of articles belonging to each class. Popularity may be gauged by the total number of citations, whereas an article's prestige can be ascertained by PageRank analysis (which displays how often an article is cited by the other, more prestigious publications). As can be seen in Table 8, which compares articles using both citation count (Tables 4 and 5) and PageRank (Table 8), it is not reasonable to assume that a highly cited article is equally a highly prestigious one (Cobo et al., 2011; Goyal & Kumar, 2021).The PageRank scores of individual articles inside each cluster

Table 8 Most prestigious articles in knowledge clusters

Article Title	Author (s)	Year	Journal Title	PageRank
Cluster 1 (240 Documents): Configuration and crucial elements of entrepreneurial ecosystems				
Toward an entrepreneurial ecosystem research program	B. Wurth, E. Stam, and B. Spigel.	2022	Entrepreneurship: Theory and Practice	0.032
Entrepreneurial ecosystem and the quality and quantity of regional entrepreneurship: A configurational approach	Z. Xie, X. Wang, L. Xie, and K. Duan.	2021	Journal of Business Research	0.024
Gimme shelter or fade away: The impact of regional entrepreneurial ecosystem quality on venture survival	S. Vedula and P.H. Kim.	2019	Industrial and Corporate Change	0.014
New(s) data for entrepreneurship research? An innovative approach to use big data on media coverage	J. von Bloh, T. Broekel, B. Özgun, and R. Sternberg.	2020	Small Business Economics	0.010
How entrepreneurial ecosystems take form: Evidence from social impact initiatives in Seattle	T.A. Thompson, J.M. Purdy, and M.J. Ventresca.	2018	Strategic Entrepreneurship Journal	0.008
The lighthouse effect: How successful entrepreneurs influence the sustainability-orientation of entrepreneurial ecosystems	S. Tiba, F.J. van Rijnsoever, and M.P. Hekkert.	2020	Journal of Cleaner Production	0.008
Entrepreneurial ecosystem elements	E. Stam and A. van de Ven.	2021	Small Business Economics	0.007
The relational organization of entrepreneurial ecosystems	B. Spigel.	2017	Entrepreneurship: Theory and Practice	0.007
The digital entrepreneurial ecosystem – A critique and reconfiguration	A.K. Song.	2019	Small Business Economics	0.007
The digital entrepreneurial ecosystem	F. Sussan and Z.J. Acs.	2017	Small Business Economics	0.006
Cluster 2 (26 Documents): Entrepreneurship for sustainability and circular economy				
Sustainable entrepreneurial ecosystems: An emerging field of research	C. Volkmann, K. Fichter, M. Klofsten, and D.B. Audretsch.	2021	Small Business Economics	0.016

Table 8 (continued)

Cluster 2 (26 Documents): Entrepreneurship for sustainability and circular economy				
University-linked programmes for sustainable entrepreneurship and regional development: How and with what impact?	M. Wagner, S. Schaltegger, E.G. Hansen, and K. Fichter.	2021	Small Business Economics	0.009
Fostering sustainable entrepreneurship by business strategies: An explorative approach in the bioeconomy	M. Urbaniec, M. Sołtysik, A. Prusak, K. Kułakowski, and M. Wojnarowska.	2022	Business Strategy and the Environment	0.004
Advocating sustainability in entrepreneurial ecosystems: Micro-level practices of sharing ventures	S. Pankov, D. Schneckenberg, and V, K. Velamuri.	2021	Technological Forecasting and Social Change	0.003
A habitat for sustainability experiments: Success factors for innovations in their local and regional contexts	H.A.R.M. van den Heiligenberg, G.J. Heimeriks, M.P. Hekkert, and F.G. van Oort.	2017	Journal of Cleaner Production	0.001
The environmentalization of urban entrepreneurialism: From technopolis to start-up city	A.M. Levenda and E. Tretter.	2020	Environment and Planning A	0.001
The diffusion of climate-smart agricultural innovations: Systems level factors that inhibit sustainable entrepreneurial action	T.B. Long, V. Blok, and I. Coninx.	2019	Journal of Cleaner Production	0.001
A review of entrepreneurship and circular economy research: State of the art and future directions	N. Suchek, J.J. Ferreira, and P.O. Fernandes.	2022	Business Strategy and the Environment	0.001
Achieving sustainability through Schumpeterian social entrepreneurship: The role of social enterprises	A. Rahdari, S. Sepasi, and M. Moradi.	2016	Journal of Cleaner Production	0.001
Commitment to sustainability in small and medium-sized enterprises: The influence of strategic orientations and management values	J. Jansson, J. Nilsson, F. Modig, and G. Hed Vall.	2017	Business Strategy and the Environment	0.001
Digital sustainability and entrepreneurship: How digital innovations are helping tackle climate change and sustainable development	G. George, R.K. Merrill, and S.J.D Schillebeeckx.	2021	Entrepreneurship: Theory and Practice	0.001

Table 8 (continued)

Cluster 3 (94 Documents): Building an innovation-driven ecosystem				
Dynamic exchange capabilities for value co-creation in ecosystems	C.A. Siaw and D. Sarpong.	2021	Journal of Business Research	0.005
Innovation, entrepreneurial, knowledge, and business ecosystems: Old wine in new bottles?	L. Scaringella and A. Radziwon.	2018	Technological Forecasting and Social Change	0.004
How entrepreneurs manage collective uncertainties in innovation ecosystems	L.A.D.V. Gomes, M.S. Salerno, R. Phaal, and D.R. Probert.	2018	Technological Forecasting and Social Change	0.004
The dynamics of openness and the role of user communities: A case study in the ecosystem of open source gaming handhelds	M.A. Zaggl, T.G. Schweisfurth, and C. Herstatt.	2020	IEEE Transactions on Engineering Management	0.003
Making the silicon cape of Africa: Tales, theories and the narration of startup urbanism	A. Pollio.	2020	Urban Studies	0.003
Mutualism in ecosystems of innovation and entrepreneurship: A bidirectional perspective on universities' linkages	P.R. Schaeffer, M. Guerrero, and B.B. Fischer.	2021	Journal of Business Research	0.003
A dynamic analysis of the role of entrepreneurial ecosystems in reducing innovation obstacles for startups	F.L. Noelia and D.C. Rosalia.	2020	Journal of Business Venturing Insights	0.002
Explicating dynamic capabilities: The nature and microfoundations of (sustainable) enterprise performance	D.J. Teece.	2007	Strategic Management Journal	0.002
The role of open innovation in developing an entrepreneurial support ecosystem	A. Pustovrh, K. Rangus, and M. Drnovšek.	2020	Technological Forecasting and Social Change	0.002
Creating the innovation ecosystem for renewable energy via social entrepreneurship: Insights from India	G. Surie.	2017	Technological Forecasting and Social Change	0.002

Table 8 (continued)

Cluster 4 (20 Documents): Knowledge, Technology, and Commercialization				
Digital Academic Entrepreneurship: A structured literature review and avenue for a research agenda	G. Secundo, P. Rippa, and R. Cerchione.	2020	Technological Forecasting and Social Change	0.004
Development of academic entrepreneurship in a non-mature context: The role of the university as a hub-organisation	V. Schaeffer, and M. Matt.	2016	Entrepreneurship and Regional Development	0.004
University entrepreneurial ecosystems and spinoff companies: Configurations, developments and outcomes	D. Prokop.	2021	Technovation	0.003
How to Green the red Dragon: A Start-ups' Little Helper for Sustainable Development in China	H.J. Steinz, F.J. Van Rijnsoever, and F. Nauta.	2016	Business Strategy and the Environment	0.003
Industry-to-university knowledge transfer in ecosystem-based academic entrepreneurship: Case study of automotive dynamics and control group in Tsinghua University	D. Meng, X. Li, and K. Rong.	2019	Technological Forecasting and Social Change	0.002
What business schools do to support academic entrepreneurship: A systematic literature review and future research agenda	G.S. Walsh, J.A. Cunningham, T. Mordue, F. McLeay, C. O'Kane, and N. Connolly.	2021	Studies in Higher Education	0.002
The governance of universities and the establishment of academic spin-offs	M. Meoli, S. Paleari, and S. Vismara.	2019	Small Business Economics	0.002
Engineering entrepreneurship teaching and practice in the United States and Canada	B.A. Schuelke-Leech	2021	IEEE Transactions on Engineering Management	0.001
Becoming an academic entrepreneur: How scientists develop an entrepreneurial identity	C.S. Hayter, B. Fischer, and E. Rasmussen.	2022	Small Business Economics	0.001
Digital startups and the adoption and implementation of lean startup approaches: Effectuation, bricolage and opportunity creation in practice	A. Ghezzi.	2019	Technological Forecasting and Social Change	0.001

enrich the content analysis and encourage in-depth discussion of how the cluster's overarching themes develop.

Cluster 1: configuration and crucial dimensions of entrepreneurship ecosystems

Cluster 1 emerged in Gephi as a modularity class, with 240 articles; it is the largest of four clusters that covers numerous sub-themes indicated by ten keywords (Table 7). On the criterion of PageRank score, Wurth et al.'s (2022) article titled "*Toward an Entrepreneurial Ecosystem Research Program*", Xie et al.'s (2021) article titled "*Entrepreneurial ecosystem and the quality and quantity of regional entrepreneurship: A configurational approach*", and Vedula and Kim's (2019) article titled "*Gimme shelter or fade away: The impact of regional entrepreneurial ecosystem quality on venture survival*" are top three prominent articles in the cluster with a PageRank score of 0.032, 0.024, and 0.014, respectively. The articles in this cluster emphasize the topic of "configuration and key aspects of entrepreneurial ecosystems" since they all have a focus on exploring the many topologies and characteristics of entrepreneurial ecosystems.

Cities (or regions) throughout the world have achieved economic growth by encouraging entrepreneurship (Song, 2019; Xie et al., 2021). Many of the featured research articles (Table 8) make an effort to give a voice to the notion of "entrepreneurial ecosystem configurations" across a range of geographical contexts (Stam & van de Ven, 2021; Thompson et al., 2018; Vedula & Kim, 2019). The discussions ranged from how the public and commercial entities have endeavored to vest interest in social stakeholders to achieve the success of new ventures (von Bloh et al., 2020; Tiba et al., 2020), to the various regulations put in place to encourage more collaboration between these entities in order to achieve innovation and business growth (Spigel, 2017; Wurth et al., 2022). Most of these articles make an attempt to find an optimal set of macro and micro conditions to foster the birth of new businesses, the expansion of existing firms, and the fortification of the value generation operation (Song, 2019; Sussan & Acs, 2017). To summarize, in this cluster, scholars have examined distinctive ecosystem configurations that are characterized by a variety of factors (Song, 2019; Thompson et al., 2018; Tiba et al., 2020; Vedula & Kim, 2019), including but not limited to human capital, favorable culture, open markets, digital platforms, financial system, governance, and regulatory measures.

Cluster 2: entrepreneurship for sustainability and the circular economy

Cluster 2 is made up of 26 articles and covers three keywords which are "sustainability", "circular economy", and "business models." Volkmann et al.'s (2021) article "*Sustainable entrepreneurial ecosystems: An emerging field of research*" is the most notable article in this cluster (Table 8), with a PageRank score of 0.016. The second most prominent article in the cluster is Wagner et al.'s (2021) article titled "*University-linked programmes for sustainable entrepreneurship and regional development: How and with what impact?*" The third most prominent article in the cluster with

a PageRank score of 0.004, is "*Fostering sustainable entrepreneurship by business strategies: An explorative approach in the bioeconomy*" authored by Urbaniec et al. (2022). The top ten spotlighted articles in Cluster 2 (Table 8) discuss the business ecosystem through the lens of environmental sustainability and circular economy.

Despite the growing visibility and importance of research on entrepreneurial ecosystems (Hubner et al., 2022; Theodoraki et al., 2022), the articles in this collection seek to fill a knowledge gap about how such ecosystems can be leveraged to promote sustainable business models which contribute to the achievement of the United Nations' Sustainable Development Goals (SDGs) (George et al., 2021; Rahdari et al., 2016; Urbaniec et al., 2022). The sustainable entrepreneurial ecosystem is distinct from the conventional one since it includes business and entrepreneurial endeavors that integrate the economic, ecological, and social aspects of sustainability into their basic operations (Jansson et al., 2017; Volkmann et al., 2021; Wagner et al., 2021). Most of the articles in this cluster have discussed on how to foster an ecosystem conducive to sustainable entrepreneurship by investigating the various forms of social (people-related) participation and technological innovation that can alleviate societal issues, permeate interest of indigenous communities, and safeguard the environment (Long et al., 2019; van den Heiligenberg et al., 2017), all while providing financial and nonfinancial benefits to the entrepreneurs and their business stakeholders (Levenda & Tretter, 2020; Urbaniec et al., 2022). Moreover, these articles have made a determined effort to present strategies in the form of business models that may be deployed to strengthen ecosystem support for attaining sustainability in businesses and developing a circular economy (Volkmann et al., 2021). Some such paradigmatic interventions include digitalized technologies (George et al., 2021), the sharing economy (Pankov et al., 2021), and university-linked courses (Wagner et al., 2021), among others.

Cluster 3: building an innovation-driven ecosystem

Cluster 3 emerges as the second largest cluster (as modularity class) in Gephi, with 96 articles. The article titled "*Dynamic exchange capabilities for value co-creation in ecosystems*" authored by Siaw and Sarpong (2021) is rated first in the cluster with a PageRank score of 0.005. Scaringella and Radziwon (2018) authored the second-ranked article, "*Innovation, entrepreneurial, knowledge, and business ecosystems: Old wine in new bottles?*", while Gomes et al. (2018) authored the third-ranked article, "*How entrepreneurs manage collective uncertainties in innovation ecosystems*". Table 7 shows that the theme of managing innovation seems to be at the heart of the ten most influential articles in Cluster 3. These articles examined the ways in which ecosystems help businesses manage their technical proficiency and business competency in order to foster the development of novel products, services, processes, and even lifestyles.

Bringing an idea to market is a collaborative endeavor that requires the participation of a wide range of stakeholders; one method to stimulate and expedite this process is to build a strong innovation ecosystem for fostering entrepreneurship. Strategic leaders, employees, inventors, value chain stakeholders, government agencies,

conglomerates, and other corporate entities are examples of actors who may either actively or passively strengthen the innovation ecosystem (Pustovrh et al., 2020; Scaringella & Radziwon, 2018; Siaw & Sarpong, 2021). Articles in this cluster have explored challenges associated with innovation activities (Gomes et al., 2018; Noelia & Rosalia, 2020) and proposed strategic solutions encompassing dynamic exchange capabilities (Siaw & Sarpong, 2021; Teece, 2007), knowledge management processes (Scaringella & Radziwon, 2018), university-supported initiatives (Schaeffer et al., 2021), and open innovation (Pustovrh et al., 2020; Zaggl et al., 2020). Moreover, scholars have examined how coworking spaces, research institutions, and government regulations, among other programs and efforts, encourage innovation and stimulate entrepreneurial activity (e.g., Crawford et al., 2023; Cabral & Winden, 2016; Jee & Sohn, 2023; Solomon et al., 2022).

Cluster 4: knowledge, technology, and commercialization

Cluster 4, the smallest cluster, consists of two keywords "academic entrepreneurship" and "technology transfer," and it has a total of 20 articles. Secundo et al.'s (2020) article "*Digital academic entrepreneurship: A structured literature review and avenue for a research agenda*" is the most notable article in this cluster (Table 8), with a PageRank score of 0.004. The second most prominent article in the cluster is Schaeffer and Matt's (2016) article titled "*Development of academic entrepreneurship in a non-mature context: The role of the university as a hub-organization*." The third most prominent article in the cluster is "*University entrepreneurial ecosystems and spinoff companies: Configurations, developments and outcomes*" authored by Prokop (2021).

The top ten featured articles in Cluster 4 (Table 8) focus on the discourse on academic entrepreneurship and technological commercialization. Academic entrepreneurship has been discussed in most of the articles in the cluster, and scholars have characterized it as the leadership process of creating economic value through acts of organizational creation, renewal, or innovation that occur within or outside the academic institution and result in research and technology commercialization (Hayter et al., 2022; Schuelke-Leech, 2021; Walsh et al., 2021). The term "digital academic entrepreneurship" appears in the cluster as well, referring to the rising prevalence with which universities are exploiting digital technologies to foster new types of academic entrepreneurship (Schaeffer & Matt, 2016; Secundo et al., 2020). These include the creation of digital divestiture and alumni start-ups, the development of entrepreneurial competence supported by digital platforms, and the expansion of innovation beyond a specific region (Ghezzi, 2019; Meoli et al., 2019; Prokop, 2021). In the cluster, there is scholarly evidence reflecting on how universities and other research institutions engage in technology transfer activities to commercialize scientific breakthroughs and new discoveries in the form of usable consumer products, medical treatments, and other social utilities (Meng et al., 2019; Steinz et al., 2016; Walsh et al., 2021).

Results: thematic mapping

Mapping research into established, emerging, and niche themes

Our analysis of the review corpus uncovers four discrete knowledge clusters, each encompassing articles addressing contemporary subjects. These subjects pertain to operational undertakings inherent to all entrepreneurial endeavors, collectively contributing to the development of a macro-level ecosystem. Next, it is imperative to assess the current state of research on the entrepreneurial ecosystem. This evaluation will serve as a compass, directing researchers towards potentially fruitful avenues of exploration. To do this, we used the "thematic map" function in the Bibliometrix-R package to grasp the themes based on their degree of relevance (centrality) and development (density) in order to establish their progression classes. Using this tool, we created an intuitive map by combining centrality and density scores to categorize themes as basic, motor, emerging, and niche (Cobo et al., 2011), with the results reported in Table 9. Each cluster has a set of author's indicated keywords which represent prominent topics, and the keywords are grouped together under the overarching archetypes that serves as the cluster's first topic. As an example, in the first grouping, labelled "basic theme," the first topic is entrepreneurship, and all subsequent topics (i.e., economic development, regional development, stakeholder, and economic growth) are connected to it.

Research themes characterized by higher citation impact ratings encompass those that are delineated as either "basic" or "motor," indicating that they have been studied extensively and have a high level of maturity (i.e., centrality). The fundamental difference between basic themes and motor themes is that the former are connected to topics within the clusters, while the latter are linked to topics suitable to other conceptually related themes (Aria & Cuccurullo, 2017; Cobo et al., 2011). Table 9 highlights three basic themes centered on "regional entrepreneurship", "innovation ecosystems", and "entrepreneurial ecosystems", which are also evident in findings of the cooccurrence network analysis (Fig. 8; Table 7). In addition, the topic of "business governance" serves as the foundation of the motor theme that links to other areas of study inside and outside of the cluster. Given the prevalence of high-quality studies that have focused on these four thematic clusters, it can be deduced that they are well-established within the research domain of entrepreneurship. Scholars may infer that, the varied factor of complex entrepreneurial ecosystem lends itself to be investigated in a variety of contexts, such as socioeconomic, political, and technical. Also seen in Table 9, there are five topic clusters categorized under emerging and niche themes. The high centrality rank of emerging themes (also called isolated themes) indicates that these clusters of topics are both extremely particular and peripheral in character, as seen by the cluster's well-developed internal links but minor outward linkages (Cobo et al., 2011). In contrast, niche themes (also known as declining themes) are considered embryonic (or immature) and have little significance in the review corpus. Table 9 labels emerging themes and niche themes as areas where interested academics should concentrate their efforts since these themes are not yet well-established but look promising.

Table 9 Centrality and density of topics in review corpus

Topics	Category (CR, DR)	Centrality	Density
Entrepreneur, economic development, regional development, stakeholder, and economic growth.	Basic Theme (1, 2)	0.102	70.721
Innovation systems, acceleration, product design, innovative product, crowdfunding, and investments.	Basic Theme (3, 4)	0.667	77.302
Entrepreneurship, ecosystems, university sector, sustainable development, business development, and technology transfer.	Basic Theme (2, 1)	0.444	63.974
Business, governance approach, institutional framework, public policy, small-medium sized enterprises, and sustainability.	Motor Theme (5, 3)	1.824	75.000
Digital platform ecosystems, climate change, gender disparity, and biodiversity.	Emerging Theme (6, 6)	5.755	90.276
Ecosystem resilience, collective action, coping strategy, and economic activity.	Emerging Theme (8, 5)	11.555	81.250
Government research and development, collaborative relationships, government interactions, and database systems.	Niche Theme (7, 9)	9.507	183.33
Sustainable entrepreneurs, social networking (online), complex networks, and sustainable business.	Niche Theme (4, 7)	1.100	113.214
Urbanization, quality of life, agriculture, and water management.	Niche Theme (9, 8)	25.543	130.000

Centrality reflects degree of relevance (i.e., closer the value of centrality to zero reflects high centrality); Density reflects degree of development (i.e., closer the value of density to zero reflects high density)

CR Centrality Rank (i.e., it reflects how closer the first topic in each cluster is related to other keywords in the same cluster), *DR* Density Rank (i.e., it indicates the cluster's degree of divergence of topics as well as quantity of associated research articles)

Avenues for future research (RQ3)

Proactive digital ecosystems for mitigating climate change

Entrepreneurs have exerted substantial influence on society, yielding outcomes both beneficial and detrimental in nature (Long et al., 2019; Wagner et al., 2021). In particular, their endeavors facilitated the emergence of enterprises that have significantly contributed to carbon emissions over the past 100 or so years (George et al., 2021; Khanra et al., 2022). Recent research has emphasized the necessity to promote the efficient utilization of limited natural resources by establishing environmentally friendly entrepreneurship ecosystems (Kanda et al., 2021; Sehnem et al., 2022). Entrepreneurs can aid innovation through driving innovation, constructing digital ecosystems, cultivating consumer demand for sustainability, impart knowledge to the public (such as through social movements), and fostering changes in behavior and culture (George et al., 2021; Khanra et al., 2022). However, further research is necessary to understand how a digital framework could expedite the adoption of these various investments.

To aid in those goals and further investigation, we encourage researchers to formulate a configurational framework that facilitates the establishment of resilient digital infrastructure for sustainability. This framework needs to be digital, as it will require interaction between geographically dispersed entrepreneurs and other stakeholders. This structure should also guide entrepreneurs towards an effective governance model, promote principles of digital citizenship, and navigate the complexities of the digital marketplace. As scholars projected (Sehnem et al., 2022; Suchek et al., 2022), the practice of decentralized organization has enabled climate activist groups to enhance their inclusivity, and digital technologies possess the potential to amplify and spread this strategy even further, making it more disruptive and prevalent across various communities (Bartoloni et al., 2022; George et al., 2021; Sehnem et al., 2022). Whatever the case, we must recognize just as the car shifted emphasis from the city, to the suburban, so will the internet shift commerce to the digital world. The following are research questions on which researchers should concentrate their efforts:

- How does the digitized commercial environment impact the feasibility of sustainable development goals, both global and local?
- How do different socioeconomic factors affect the growth of a digital ecosystem to support green economy and climate change response initiatives?
- To what degree and in what mechanisms can social movements be effective in projects that advocate for digital sustainability within the entrepreneurial sphere?
- How can environmentally harmful business entities become integrated into digital sustainability initiatives, assuming greater accountability and active contribution within the framework of climate change action?
- What issues emerge from digital ecosystems dedicated to sustainability? How can we overcome inertia and build trust in this new type of an ecosystem?
- The definition of entrepreneurial ecosystem has a focus on geography. How does the shift to digital ecosystems upend that definition?

Coping strategies and ecosystem resilience

Despite significant interest in studying entrepreneurial ecosystems, scholars have not adequately researched the distinctive dynamics of various ecosystems nor what drives differences between ecosystems (Khurana et al., 2022; Roundy et al., 2017). There has been little academic evidence on the fundamental property of ecosystem health, which indicates the capability to change and evolve in response to disturbances caused by fluctuating external and internal circumstances (Galappaththi et al., 2017; Iacobucci & Perugini, 2021). Inferring from this, it can be posited that heightened ecosystem resilience will enable entrepreneurial ecosystems to rebound from more profound disruptions, subsequently shortening the period required for the strained system to adapt (Roundy et al., 2017). Given that little is known about the disruptions that an entrepreneurial ecosystem may confront (Iacobucci & Perugini, 2021; Khurana et al., 2022), we call for studies on the coping strategies that are necessary in the event of an entrepreneurial ecosystem disruption.

Researchers may delve deeper, providing additional insights on the ecosystem's requisite transformation, especially in light of how ecosystems disturbance links to adjustments in social behavior and functional architecture. Scholars may provide evidence of the greater context in which an ecosystem's resilience to perturbation and subsequent recovery of original function may be understood, as well as how an entrepreneurial ecosystem might emerge stronger even after a major disruption (Galappaththi et al., 2017; Iacobucci & Perugini, 2021). Such perspectives would facilitate a detailed understanding of the degree to which disruptions can adversely affect individual entrepreneurs, highlighting the personal stakes within broader ecosystem dynamics. Following are a few potential avenues for future researchers to explore under the category of this emerging theme.

- How do entrepreneurs deal with the uncertainty of scaling their businesses in the early stages, when resources such as funding and alliances are scarce? How could an entrepreneurial ecosystem be established to meet the requirements of such new businesses, considering the diverse range of geographical contexts?
- What are the coping strategies for dealing with the uncertainties inherent in innovation projects, particularly in the face of societal upheavals such as pandemic and war?
- How does the degree of tension between the different actors in the entrepreneurial ecosystem change as a consequence of cultural diversity and cohesiveness at various levels, and how does this affect the ecosystem's resilience and behaviors?
- What is impact of the coping mechanisms (during an exogenous shock) to existing governance mechanisms (governments and markets) in the ecosystem?

Role of government in the entrepreneurship ecosystem

Achieving sustainable economic growth necessitates finding a harmonious equilibrium among the diverse components of the entrepreneurial ecosystem (Steinz et al., 2016; Xie et al., 2021). The government plays a pivotal role in instituting

a governance system that orchestrates the interactions among funding entities, regional culture, business entities, and the marketplace (Meoli et al., 2019; Tiba et al., 2020; Vedula & Kim, 2019). The prior literature is relatively reticent and contains little discussion on this subject, prompting future scholars to investigate the function of government in encouraging the entrepreneurial ecosystem while taking into account political realities in different countries (van den Heiligenberg et al., 2017; Johnson et al., 2022). Scholars can also highlight the factors that have either facilitated or hindered the cultivation of the entrepreneurial ecosystem in the context of both developing and developed countries. This can be achieved by discerning distinctive factors such as infrastructural evolution, policy intervention, support for research and development, entrepreneurial characteristics, market regulation, and the ecosystem of financial backing, among other pertinent considerations (Steinz et al., 2016; Tiba et al., 2020). To accomplish this objective, it is critical to examine how government agencies preserve database records, since this will give insight into the collaborative nature of relationships between regulatory agencies and enterprises of all sizes (Johnson et al., 2022).

However, in examining the role of government, it is imperative to also consider the critical influence of politics within governance structures. Politics, often characterized by the exchange of favors within the business sphere, plays a decisive role in shaping governmental actions that enable or constrain business activities. Furthermore, understanding the interconnections between government, social networks, and the market is essential to comprehensively assess how they collectively impact the functioning of the entrepreneurship ecosystem. Given the niche nature of this topic, future researchers might investigate the following research questions.

- What actions may be taken by the government to promote an environment that encourages the expansion of new businesses and the innovation efforts of small and medium-sized businesses?
- What actions should the government take to encourage academic institutions or corporate entities to recognize and assist grassroot innovators from the informal education community, particularly in technology transfer and commercialization activities?
- What measures can the government take to stimulate localized entrepreneurship and meet the requirements for a self-sufficient economy?
- How important is the government compared with markets and social networks?

Some scholars are less confident about the ability of the government to influence ecosystems (Steinz et al., 2016; Xie et al., 2021). In particular, a reason why scholars have been reticent about government interventions in ecosystems is because the role of the government is complex in that it can aid and hinder entrepreneurial growth. Outside of the protection of property rights, there is little agreement on the nature of government intervention. Indeed, there is considerable evidence that government intervention in entrepreneurship may lend itself to rent-seeking (e.g., unproductive entrepreneurship that does not enrich society) and other nefarious activities that damage economic growth (Baumol, 1996; Muldoon & Yonai, 2023; Steinz et al., 2016; Tiba et al., 2020; van den Heiligenberg et al., 2017). Other scholars are

more confident that the government should get involved in entrepreneurial matters through socializing risk that will enable radical innovation (Mazzucato, 2013).

- What government and political factors lend themselves to rent-seeking and poor ecosystem maintenance?
- To what extent does the government getting involved as an investor (e.g., the entrepreneurial state) damage existing property rights? What influence do lobbyists play in distorting property rights in the entrepreneurial state?
- Is rent-seeking always bad for the entrepreneurial ecosystem?
- Does rent-seeking crowd out productive entrepreneurship?
- Does the hunt for sustainability promote rent-seeking? This is an important question given the number of subsidies that green energy gets.

Social networking for sustainable entrepreneurship

The intersection between social networking platforms and sustainable entrepreneurship is another fruitful avenue for future research in the area of entrepreneurial ecosystem. Amidst the efforts of global climate action leaders to devise approaches for collective intervention against climate change, social networking platforms have emerged as vital channels for fostering social collaboration, facilitating social marketing, enabling crowdfunding, and facilitating crowdsourcing initiatives (Manning et al., 2022; Presenza et al., 2019; Troise et al., 2024). Indeed, Troise et al. (2024) provide an insightful explanation of crowdfunding through teams, yet further research is necessary to understand how these teams form and coordinate among dispersed actors. Although we have explained the digital ecosystem for sustainable entrepreneurship as a potential research avenue, social networking platforms are classified as a niche theme. As such, we call for future research to investigate the following research questions to acquire a more in-depth understanding of the field.

- To what extent could social media platforms be utilized to tap into the wisdom of a global community of experts, in order to better comprehend societal challenges and identify feasible solutions? What role may a digitized strategy serve in cultivating a healthy environment for sustainable entrepreneurship and the growth of its supporting ecosystem?
- To what extent can the impact of different social media on marketing be quantified by using a model that takes a holistic approach and is grounded in empirical data?
- To what extent can the performance of sustainable entrepreneurs be enhanced by the use of social media platforms, and what types of social capital (e.g., cognitive, relational, and structural) may be developed in this way?
- How effective are social media platforms in addressing radical issues when there is a tangible intervention by sustainable entrepreneurs or ventures?
- To what extent do teams converge to facilitate funding, and what mechanisms underpin their coordination?

Urban quality of life and entrepreneurship

Contemporary urban residents predominantly rely on the internet, applications, and smartphone technologies to swiftly address challenges and uphold uninterrupted functionality within the city. Recently, the focus of discussion has transitioned towards nurturing the expansion of entrepreneurial ecosystems or the rise of entrepreneurs who can contribute to enhancing the local economies of various cities and towns across a country (Battisti et al., 2022; Pollio, 2020). With the urban environment rapidly expanding, the complexities of everyday city life are anticipated to grow. This is precisely where entrepreneurs step in, crafting solutions aimed at elevating the living standards of urban residents (Levenda & Tretter, 2020; Pollio, 2020). Several innovative solutions originating from urban entrepreneurship, such as navigation, location indicators, traffic management, mobility, search services, on-demand services, e-commerce, agriculture, security, and water management, among others, have helped people enjoy a better quality of life (Levenda & Tretter, 2020; Mack & Mayer, 2016). This cluster is a niche theme that aims to reconcile urban quality of life with entrepreneurship, perhaps necessitating more scholarly insights by addressing the following research questions.

- How do entrepreneurial ecosystems interact with public and other commercial ecosystems in urban areas, and what are the relevant spatial configurations of urban entrepreneurship?
- How can the stages of progression of the entrepreneurial ecosystem for urban entrepreneurship be characterized, especially in the context of the industrial and service sectors?
- How can we assess the effectiveness of regulatory initiatives meant to stimulate entrepreneurship and business growth in metropolitan areas?
- How does the passage of time influence the dynamics of entrepreneurial ecosystems, in particular the formation of alliances, the expansion of platforms, and the fundraising or funding access?
- What are the infrastructure challenges that urban entrepreneurs face when working with rapidly evolving technologies (e.g., artificial intelligence, internet of things, or information and communication technologies) to solve large-scale problems like agriculture, water management, traffic management, and so on?

Conclusion

This paper presents a comprehensive retrospective review of 380 journal articles concerning entrepreneurial ecosystems, employing both performance and scientific mapping analyses to address three pivotal research questions (RQs).

Identification of key contributors (RQ1): Our findings underscore the significant contributions of journals such as *Small Business Economics, Technological Forecasting and Social Change*, and *Entrepreneurship and Regional Development*, highlighting these journals' central role in publishing seminal works on entrepreneurial ecosystems. Notably, the *Strategic Management Journal* emerged as a leading

source in terms of citations, indicating its pivotal influence on the field. This analysis also recognizes the contributions of key researchers, including David Audretsch, and institutions like Utrecht University, thereby mapping the landscape of intellectual contributions to this domain.

Knowledge Clusters and Thematic Analysis (RQ2): The performance analysis revealed a consistent growth in publications over the last three decades, signifying escalating interest in entrepreneurial ecosystems. Our scientific mapping identified four dominant themes: ecosystem configuration, sustainable entrepreneurship, innovation ecosystems, and academic entrepreneurship. This thematic exploration emphasizes emerging areas such as digital ecosystems for climate change mitigation and the role of government, suggesting avenues for future research to deepen our understanding of entrepreneurial ecosystems.

Future Research Directions (RQ3): Addressing critiques by Spigel (2022) regarding the predominant focus on exceptional cases like Silicon Valley, we advocate for a broader examination of entrepreneurial ecosystems, including their potential drawbacks and the intricacies of intra-ecosystem coordination. Drawing on theories by Ostrom (1990) and Fiske (1992), we highlight the importance of social relations and government regulations in shaping entrepreneurial activity. Furthermore, the evolving concept of geographic regions necessitates a reevaluation of the role of government policies and their impacts on local and regional economies (Muldoon et al., 2024).

Our review not only delineates the current state of research on entrepreneurship ecosystems but also proposes critical areas for future investigation. These include the role of government in developing countries, the emergence of digital ecosystems, and the exploration of cultural influences on ecosystem dynamics. For example, the unique cultural context of the Boston area offers a compelling case study on the interplay between historical legacies and technological innovation. Additionally, we underscore the importance of examining the dynamics between state and corporations, hybrid organizational forms, and the impact of social support structures on entrepreneurial success.

In conclusion, while the field of entrepreneurship ecosystems is marked by robust scholarly attention, it remains ripe for further exploration. Future research should aim to develop theoretical frameworks that elucidate the diverse factors influencing ecosystems' performance, with a particular focus on the nuanced role of government, cultural context, and social dynamics. This will not only enrich our understanding of entrepreneurship ecosystems but also contribute to the formulation of policies that foster innovation and economic growth.

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Declarations

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