



Academic Entrepreneurship Ecosystems: Systematic Literature Review and Future Research Directions

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Abstract

Research on the entrepreneurship ecosystem, based on different data and scales, limits the acceptance of a single definition. This conceptual limitation and the still recent research and higher education institutions have come to be seen as ecosystems associated with entrepreneurship. The aim of this study is to contribute to the field of knowledge, identify current and emerging thematic areas and trends and reveal the scientific roots of research on entrepreneurial ecosystems and their relationship with higher education institutions. A bibliometric analysis was developed to analyse a final sample of 110 articles published between 2011 and 2022. In order to develop the analysis, *Bibliometrix R-Tool* was used and the metadata of two databases (Web of Science and Scopus) was retrieved and merged. The software creates a reference co-citation's map, which allowed emphasize the state of the art and indicate three thematic clusters: (i) the importance of the higher education context for the entrepreneurial ecosystem, (ii) the evolution and challenges of entrepreneurship education and (iii) academic entrepreneurship ecosystems. The paper concludes by suggesting future research focused on the importance of building an integrated approach to entrepreneurial ecosystems and higher education institutions on a context regional scale.

Keywords Academic entrepreneurship · Entrepreneurial ecosystems · Higher education institutions · Universities · Bibliometric analysis · Systematic literature review

Introduction

The new research on the “entrepreneurship ecosystem” (EE) limits the acceptance of a single definition. According to this conceptual limitation and the still recent research, higher education institutions (HEIs) have come to be seen as ecosystems associated with entrepreneurship. While several bibliometric and

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systematic literature reviews have advanced for a research agenda for academic entrepreneurial ecosystems (AEEs), a holistic approach that integrates theories, attributes and methods is still necessary.

The concept of EE in HEIs has emerged in the literature (Fetters et al., 2010). Consequently, initial studies have addressed the components of these ecosystems (Fetters et al., 2010; Graham, 2014; Meyer et al., 2020), and internal and external actors have been identified (e.g. Hayter, 2016; Hayter et al., 2018; Meyer et al., 2020). Hayter (2016) and Hayter et al. (2018) further elaborated on the research by relating the effectiveness of academic EEs to the levels of the interconnectedness of the constituent elements and their collective capacity.

Higher education institutions (HEIs) and their surroundings play a “fundamental role for contemporary societies in the field of education and knowledge generation” (Kobylińska & Lavios, 2020: 118). For the authors, during the last decade, the university and its surroundings have become a special ecosystem. Specifically, favourable conditions are created for cooperation between various entities, namely, HEI, business incubators, technology transfer centres and funding institutions, which contribute to developing academic entrepreneurship ecosystem (AEE) (Meyer et al., 2020; Kobylińska & Lavios, 2020). The combination of EE and HEI requires further research.

The systematic literature review (SLR) developed in this article found five studies that allow us to assess what is known about this subject. Malecki (2018) reviews the literature, concepts and operationalizations of the concept of EE with a bibliometric analysis. Kansheba and Wald (2020) present a systematic review of the existing literature, develop a research agenda and analysing, only, articles that focused on EEs (conceptual, theoretical or empirical). They concluded that the concept of EEs is poorly theorised and dominated by conceptual studies, revealing existing theoretical and empirical gaps on EEs. In the third SLR found, Kobylińska and Lavios (2020) aimed to analyse the state of research on University EE and to identify research trends related to the topic. They concluded that the study of University EE is little recognized in the literature, lacking a solid methodological basis and revealed that the topic may constitute a research area of interest. In the fourth review, Guindalini et al. (2021) present an SLR with bibliometric and network analysis, with the aim of mapping AEE. In this SLR, as in the two previously mentioned, the authors conclude that this topic is at an “embryonic stage of academic research” (Guindalini et al., 2021: 6). They also find a gap in research regarding evaluation studies that support the targeting of potential scientific discoveries in the market. With bibliometric and SLR, the study develops a holistic framework that integrates sustainability factors into the EE literature. They confirm that EE research has mostly focused on academic entrepreneurship, innovation and regional development, among others.

The originality of this research is directly linked to the chosen emerging theme. In this context, this study aims to complement and stand out from the five reviews found and understand the characteristics of an AEE and their successful development as a potential research area relevant in the future. To this end, a bibliometric analysis is proposed to answer the following research questions: (a) RQ1: Is it possible establish common attributes for AEE?; (b) RQ2: What are the opportunities and

challenges that HEIs must recognize to achieve an successful EE?; (c) RQ3: What key areas require further research with regards to AEE?

In order to complement the proposed research questions, this study also responds to the subsequent objectives: to provide a comprehensive overview of the origins of the EE concept, to explore the research conducted so far in this field of study, to reveal the scientific roots of research on EEs and their relationship with the HEIs and to create knowledge for future research on AEEs.

To achieve them, the SLR followed in this article included a rigorous protocol and definition of research steps and a literature review based on scientific articles published in Web of Science (WoS) and Scopus. In addition, the 110 articles related to EEs were submitted to a bibliometric analysis with the *Bibliometrix-R tool*. In this quantitative bibliometric, we used the analysis of co-citations, which allowed obtaining a citation network composed of clusters.

The article is structured in seven parts. After this introductory section, the theoretical framework on the concept is presented in the second section of the paper and is organized as follows: entrepreneurial ecosystems and academic entrepreneurial ecosystems. In the third section, the methodological characteristics of the research used in the SLR, the sample and the bibliometric analysis method are presented. The results are explained in the fourth section. The thematic analysis exposing the resulting visual maps and discussing the results of the articles classified by clusters is the fifth section. In the sixth and final section, the future lines of research and conclusions are addressed presenting limitations that resulted from the review and future of research.

Theoretical Framework

Defining Entrepreneurial Ecosystems and Academic Entrepreneurship Ecosystem

The concept of entrepreneurial ecosystem is an ambiguous term, but, in fact, this concept has been increasingly explored by researchers over the years (Bischoff et al., 2018; Clarysse et al., 2014; Cohen, 2006; Isenberg, 2010, 2011; Kansheba & Wald, 2020; Stam & Spiegel, 2017; Van de Ven, 1993). The term entrepreneurial ecosystem (EE) is a composite of two terms.

The component of the term—entrepreneur—according to Mason and Brown (2014) is often associated with “high growth start-ups” or “economies of scale” as being a source of innovation and growth in productivity and employment. The other component of the term—ecosystem—is associated with biology and is defined as the physical environment and all possible interactions in the complex of living and non-living components (Stam, 2015). As in ecology, the biological perspective focuses on the rise and fall of many organizations and institutions that are mutually related and play different but complementary roles that enable their birth, growth and survival (Astley & Van de Ven, 1983; Freeman & Audia, 2006).

Cohen (2006) was the first to use the concept of EE building on the study of Neck et al. (2004). Neck et al. (2004) used qualitative analysis to identify the components present in the EE in Boulder, USA. This concept became more prominent through

Daniel Isenberg, in 2010. For this author, an EE is a set of individual elements combined in a complex way. In isolation, each can generate entrepreneurship but cannot sustain it (Isenberg, 2010, 2011). Mason and Brown (2014: 5) more broadly defined an EE as a “set of interrelated entrepreneurial actors, entrepreneurial organizations, institutions and entrepreneurial processes that formally or informally cooperate in relating and mediate performance within the local entrepreneurial environment.” Audretsh and Belitski (2017: 1031) define EE as “institutional and organisational systems as well as other systemic factors that interact and influence the identification and commercialisation of entrepreneurial opportunities.” Acs et al. (2014) defined entrepreneurial ecosystems as a dynamic, institutionally embedded interaction between entrepreneurial attitudes, capabilities and aspirations of individuals that drives the allocation of resources through the creation and operation of new projects. Stam and Spigel (2017) point out that it is the coordination that occurs between actors and interdependent factors that enables productive entrepreneurship in each territory.

As this term has captured the attention of researchers, experts and policymakers significant knowledge gaps have also emerged in terms of its conceptual meaning, theoretical foundation and application (Audretsh et al., 2019; Kansheba & Wald, 2020). According to Audretsh et al. (2019), the question remains as to what exactly an EE is and what it comprises. It also mentions that the definition of EE does not add value to academic discourses that rely on “networks”, “cluster initiatives”, “triple helix initiatives” or “public–private partnerships”. For the authors, thinking in terms of EEs may only reflect the importance of a particular topic, such as “business ecosystems”, “digital ecosystems”, “financial ecosystems” and “university ecosystems”, among others.

Combining EEs and HEIs: An Overview of Academic Entrepreneurship Ecosystems

In recent decades, some universities have oriented themselves towards a more entrepreneurial direction through the realization of the third mission as a key player in promoting national and regional economic and social development (Etzkowitz & Leydesdorff, 2000; Yi & Uyarra, 2018) resulting from the interaction of three actors belonging to different helixes—university–industry–government: triple helix model (Etzkowitz & Leydesdorff, 2000). Etzkowitz and Zhou (2017) point out that the thesis of the model is that the university starts to abandon a social, yet important, role of providing higher education and research and starts to assume an essential role equivalent to that of industry and government as a generator of new industries and enterprises. As a result, the entrepreneurial university has become an increasingly significant academic configuration and is considered a vital element (Etzkowitz & Zhou, 2017; Wang et al., 2021). Pita et al. (2021) agree, pointing out that universities actively contribute to the development of EEs by providing a skilled workforce and stimulating new enterprises, such as start-ups or spin-offs.

In the entrepreneurial university, knowledge-sharing processes are outlined, which requires the university to reconfigure its traditional educational programmes and approaches to create a favourable context for university entrepreneurship by

supporting students in a process that moves from idea generation to idea development, business model and commercialisation (Secundo et al., 2021). Another challenge facing HEIs is to shift their focus from education about entrepreneurship to educating for entrepreneurship. This encompasses any programme or pedagogical process of education aimed at achieving entrepreneurial skills and attitudes (Bischoff et al., 2018).

Against entrepreneurial HEIs and their pedagogical competencies of entrepreneurship education, researchers highlight that the entrepreneurial university itself can form an EE (Miller & Acs, 2017; Wang et al., 2021). The EE developed with an academic campus as a context is referred to as “University-based Entrepreneurship Ecosystem” (UBEE) or “University Entrepreneurship Ecosystem” (UEE) or “Academic Entrepreneurship Ecosystem” (AEE). All these terms refer to the ecosystem developed on the university campus, which are part of a wider ecosystem. For Wang et al., (2021: 2), the creation of UEEs, currently, is a “hot topic.”

Naturally, many definitions were put forward, leading to the decision to present, chronologically, a selection of definitions (Table 1).

An effective AEE is critical for entrepreneurial academic activities as they not only act as a catalyst for the acceleration of knowledge commercialisation but also as a platform and dynamic in maintaining the sustainable development of academic entrepreneurship (Yi & Uyerra, 2018). However, little literature exists on the AEE’s structure and function and particularly how the transition from the academic entrepreneurial system to an AEE occurs (Hayter, 2016; Yi & Uyerra, 2018).

Table 1 Definitions of entrepreneurship ecosystems

Authors	Definitions UBEE/UEE/AEE
Fetters et al. (2010)	An UBEE is integrated and comprehensive, linking teaching, research and outreach, and is set in the context of the whole university and its wider community with the aim of fostering system-wide entrepreneurial thinking and action An UBEE can be part of a set of EEs which, when linked together, create a meta-EE that operates at a regional and, in some cases, national and global level
Hayter (2016)	An AEE is the set of strategic and collective actions of various organizational components—referred to as knowledge intermediaries—in order to maximize both the entrepreneurial and innovative contributions of universities
Yi and Uyerra (2018)	An AEE is a set of academic entrepreneurial actors (e.g. universities, other higher education institutions, research institutions, companies, venture capitalists) and factors (e.g. entrepreneurial capacity, university leadership, governance and markets, support structures), which coexist and interact through mechanisms of the academic entrepreneurial process in order to develop a dynamic and interactive community in order to achieve the goal of knowledge commercialisation
Meyer et al. (2020)	An UBEE is based on the study of potential variables that contribute to its analysis and growth, whether internal (students, faculty, entrepreneurs, university administrators, support staff) or external (investors, mentors, managers, service providers, government actors, regional entrepreneurs) to the university
Wang et al. (2021)	An UEE is a network system with complex elements including individuals, organizations, curricular and extracurricular activities and capital. Among them the head of extracurricular activities is the key piece that links campus entrepreneurs to resources, playing the role of service and connector

Source: Based on the literature review

Similarly, to research on EE, academics attach greater importance to the conceptualisation and elements of the UEE. Several authors identify the factors contributing to the evolution of EEU (Fetters et al., 2010; Graham, 2014; Meyer et al., 2020). Fetters et al. (2010) cite seven factors contributing to the evolution of UBEEs: senior leadership, strong teaching and programmatic capacity, long-term commitment, the commitment of financial resources, the commitment to continuous innovation in programmes and curricula, adequate organizational infrastructure and the commitment to increasing critical mass and creating enterprises. Graham (2014) also identifies seven factors that underpin UEEs: institutions, culture, university leadership, university research capacity, regional or governmental support, effective institutional strategies and strong demand for entrepreneurial students.

Brush (2014) believed that entrepreneurship education is the core of the UEE. The researcher divided the internal entrepreneurial education ecosystem into three broad areas (introductory/curricular courses, extracurricular activities and research) and four dimensions (stakeholders, resources, infrastructure and culture). Sherwood (2018), in addition to the elements, identified curricular, extra-curricular components, Technology Transfer Offices (TTO), resources and informal and community engagement. For Wang et al. (2021), diversified extracurricular activities have played an important role in stimulating students' interest in entrepreneurship by providing them with a large number of resources. For the authors, student entrepreneurs also tend to get the guidance and resources they need through these activities.

For Bischoff et al. (2018), although the concrete strengths and conceptualization of UBEEs generally vary between universities, a number of common characteristics can be identified. Secundo et al. (2021) mention that UBEE facilitates innovation and entrepreneurial opportunities thanks to the knowledge-sharing processes between the various actors. Within a UBEE, for the author, each actor needs to be connected to the other members through a constant flow of knowledge from information that enables the overflow of entrepreneurial knowledge. The author points out that universities may assume different roles according to the size and composition of the entrepreneurial ecosystem, interacting through different channels.

In accordance with the review carried out, the other authors initiate the development of methods to evaluate an AEE. Table 2 shows three of the conceptual models highlighted in the literature review and published chronologically in the last 5 years.

Within this context, further research work on evaluations of AEE is needed. The findings draw attention to considerations as "unique entrepreneurial architecture" (Prokop & Thompson, 2022: 17). The Prokop and Thompson (2022: 181) study include 81 UEE and, according to the author, "it is in no way reflective of all types of sub-ecosystems, or broader ecosystems." The study of university and broader EEs is a critical feature to recognize and involve in future studies. This study aims to contribute to this challenge.

Methodology

To produce a comprehensive review article, Hulland (2020) refers that authors should carry out their studies in a systematic way. A systematic review needs the definition of clear questions, criteria and conclusions that provide new information

Table 2 Review on the conceptualisation of models for the assessment of EE in HEI

Authors (year)	Type	Elements of AEE/UBEE/UJEE	Limitations and future research areas
Yi and Uyerra (2018)	Qualitative Interviews <i>Case studies</i>	<p>AEE (levels IOE):</p> <ul style="list-style-type: none"> • Individual: applied research, motivation and capacity • Organizational: fulfilling the 3rd mission, management organizational, collaborative academia • Environmental: supporting policies and programmes, infrastructure <p>AEE Process Mechanisms—(ICC)</p> <ul style="list-style-type: none"> • Incentive: investment in entrepreneurship • Collaboration: improve organizational structure, develop networks • Capacity: develop academic entrepreneurial skills; develop supporting capacities 	<p>The authors proposed a model to assess the AEE of Zhejiang University through three levels (IOE) and three mechanisms (ICC)</p> <p>Limitations</p> <ul style="list-style-type: none"> • As EEA is a dynamic process, further studies would benefit from models with stages of development <p>Future research:</p> <ul style="list-style-type: none"> • Further analysis can focus on the influence of other factors such as seeking entrepreneurial opportunities and avoiding their risks

Table 2 (continued)

Authors (year)	Type	Elements of AEE/UBEE/UEE	Limitations and future research areas
Meyer et al. (2020)	Qualitative Interviews Case studies	<p>UBEE evaluation levels:</p> <ul style="list-style-type: none"> ● Internal primary actors ● External primary actors <p>Endogenous ecosystem factors</p> <p>Factors external to the ecosystem</p>	<p>The authors proposed a model to support and boost university entrepreneurship. They designed an UBEE assessment tool, targeted at universities in the USA, South Korea and India</p> <p>Limitations:</p> <ul style="list-style-type: none"> ● Faculty recruitment policies for Institution teaching are divergent from each other and deserve more attention <p>Future research:</p> <ul style="list-style-type: none"> ● Analyse the impact of cultural differences on university entrepreneurship ● Dedicate more importance to curricular internships as part of higher education (case of Korea there are no internships) since it is motivating for the student to become entrepreneurial ● Check gaps in core competencies in the field of entrepreneurship ● To deeply analyse the factors external to the university since they can have a profound impact on entrepreneurs ● First, study the entrepreneurship education, incubation and networks of the university to build the EE
Wang et al. (2021)	Qualitative Interviews Case Studies	<p>Analysis of factors affecting the formation and operationalization of the UEE</p> <ul style="list-style-type: none"> ● Extracurricular activities ● Networks as connecting elements: personal networks, campus network, national or global network ● Entrepreneurial culture: values, entrepreneurial environment, networking ● Leadership 	<p>Limitations:</p> <ul style="list-style-type: none"> ● Since this is a qualitative study, generalization of the research findings is limited ● The study only took place in a single period, so it can only provide information about one phase of the development of the UEE <p>Future research:</p> <ul style="list-style-type: none"> ● Since the study took place in a US university, the results found may be different, so it is necessary to expand the study of UEE ● As the development of UEE will change over time, it will go through several phases that only with the inclusion of the 'time' dimension can be investigated ● The performance of entrepreneurial teachers in UEE formation is also a future direction that needs to be considered

based on the examined content. According to Aria and Cuccurullo (2017), this means that the phases adopted in the review can be replicated in all procedures and there should be clarity in all of them. The authors state that the working model of an SLR is based on five stages: study design, data collection, data analysis, data visualization and interpretation.

Ferreira et al. (2019) mention that one of the most suitable methods for analysing past research works is bibliometric analysis. According to Aria and Cuccurullo (2017) and Thelwall (2008), there are relevant points when using bibliometric. For Aria and Cuccurullo (2017), there are three types of research questions that can be answered using bibliometrics: identify the knowledge base of a topic or field of research, examine the conceptual structure of a topic or field of research and produce a network structure based on a particular scientific community. The relevance for Thelwall (2008) concerns the types of procedures in bibliometric analysis. The author identified two types of procedures, evaluation bibliometric and relational bibliometric. The first evaluates the productivity and impact of researchers, research centres and countries. The second type examines the similarity and relationship between publications, authors and keywords using co-word, co-authorship and co-citation analyses.

The article will use the suggestions of both authors in bibliometric analysis. It will respond to the three types of questions posed by Aria and Cuccurullo (2017) and uses both types of procedures, evaluation bibliometric and relational bibliometric. In evaluation bibliometric, mappings, qualitative analyses and baseline indicators are carried out. In relational bibliometrics will analyse co-citations and the respective clusters.

Data Collection and Eligibility Criteria

In additional search, the research papers were determined through the comprehensive advanced search in two databases including Scopus and Web of Science. These choices were justified for two reasons: they are two multidisciplinary databases that include all indexed journals with the highest number of citations in their respective areas of scientific specialization (Huang et al., 2020; Pranckutė, 2021). They also provide a citation index, generating information about each publication in documents that cite them as well as cited.

Table 3 elucidates the stages that followed in this study.

The keywords come from the research question and was defined the following search query: “entrepreneur* ecosystem*” (in title) AND “universit*” OR “polytechnic*” OR “higher education institution*” (in topic). All the articles from the current year were excluded because at the time of this research the year had not finished. The document type was limited to “article” and “review.” After applying these criteria, it was obtained 183 papers from the research process (104 obtained in SCOPUS and 79 results in Web of Science) (stages 1 and 2 from Table 3 and Fig. 1).

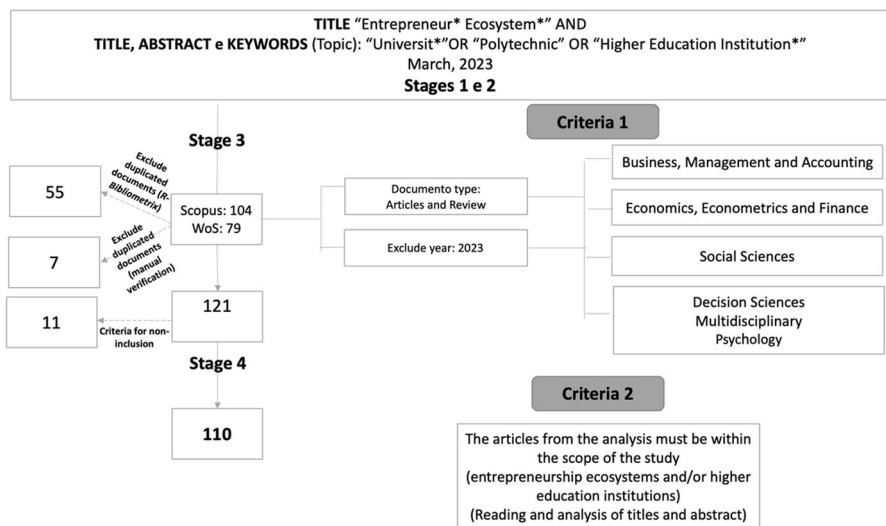
Table 3 Stages for bibliographic search

Stages	Description
(1) Research protocol	Research by TITLE (“entrepreneur* ecosystem*”) AND TOPIC (“universit*”) OR (“poly- technic*”) OR (“higher education institution*”)
(2) Data Search	March, 2023 Articles from 2023: excluded Document type: article and review
(3) Eligibility criteria	1: Document type: subject areas 2: Out of the scope of the study
(4) Data extraction	Final Database – <i>Excel e Bibtex</i> format
(5) Analysis and synthesis of results	Qualitative and quantitative
(6) Discussion of the results	Exhaustive content analysis

In the third stage, wherein some records were excluded, the data was filtered. To this end, other restrictions were applied:

- Eliminating the repeats by cross-referencing the databases (62 documents)
- The exclusion of 11 documents, after analysing the content of each, because the global subject of the articles was different from the scope of the study

Although language was not a filter, it should be noted that the search was developed utilizing English, which could be understood as “quasi-filter.”

**Fig. 1** Process of data collection and analysis

The procedures followed in the data collection and the application of the eligibility criteria complete Fig. 1 which demonstrates the careful way in which the final database was obtained ($n = 110$).

Results

Mapping and Qualitative Analysis

R-Bibliometrix summarized the mapping of the documents included in the final database with the information considered relevant, as shown in Table 4. Table 4 reveals that the dataset contains 110 documents published between 2011 and 2022, representing the work of 276 authors from 32 different countries. The average years from publication is 3.31 and the average number of citations per documents 13.4. The number of authors and co-authors per document is 2.5 and 2.7.

The first study in the final database addressed the entrepreneurship ecosystems, and the global innovation networks were written by Malecki in 2011. For the author, the existing knowledge is dispersed as it results from entrepreneurial activity originating from small and medium enterprises, research institutes and universities. Malecki (2011) suggested the simultaneous integration of local and global knowledge as well as internal and external.

A reading of Tables 4 and 5 reveals that various articles have been published recently (during 2011–2022). Moreover, an increase of publications (except 2012 and 2013) shows an increasing trend, suggesting that the subject has been

Table 4 Main information ($n = 110$)

	2011–2022
Timespan	
Sources (Journals, books etc.)	75
Documents	110
Article	107
Review	3
Document average age	3.31
Average citations per documents	13.4
References	4152
Document content	
Keywords plus (ID)	305
Author's keywords (DE)	343
Authors	
Authors	276
Authors of single-authored documents	18
Authors per document	2.5
Co-authors per document	2.77
International co-authorship %	19.09

Table 5 Evolution of number of articles and citations

Year	N° documents	Average citations per documents	Average citations per year
2011	1	83	6.92
2014	2	17	1.89
2015	1	24	3.00
2016	1	4	0.57
2017	7	20	3.33
2018	14	25.14	5.03
2019	23	19.65	4.91
2020	17	2.29	0.76
2021	20	5.55	2.77
2022	24	9.79	9.79

Annual scientific production—33.5%

progressively gaining popularity in the academic community. The results reveal and confirm the increase prevalence of research on EEs over the past 11 years.

In 2022, the number reached 24 articles in the last year of the period. After 2014, there was a considerable increase in the number of published articles. The data shows a turning point in 2018 (14) and 2019 (23). This latter year and 2022 standing out with the highest number of published articles. It is important to mention that more than half of the articles (62) were published in the last 3 years. The production growth rate is 33.5%.

According to the average number of citations, per year, the articles written in 2022 were those with a higher number (9.79) followed by articles from the years 2011, 2018 and 2019. This increment in the interest of EE results from the fact that this concept has assumed a global and multidisciplinary dimension recognized and associated with innovation by the various economic and social actors.

Table 6 presents the five authors and journals that have contributed for research's development. The most cited papers by author were those of Malecki, with 185, followed by Audretsh, with 111, and Carayannis, with 110. The three authors who have published the most with the highest local impact (TC index) are Cunningham (4 publications, TC 156), Audretsh (3 publications, TC 184) and Menter (3 publications, TC 154).

R-Bibliometrix software was used to identify the keywords mentioned in the 110 documents of the final sample. As can be seen in the Fig. 2, the most frequently terms mentioned are “entrepreneurial ecosystem”, “entrepreneurial university”, “entrepreneurial education”, “university”, innovation” and “higher education”. This also shows that of the studies analysed word association results as “academic entrepreneurship”.

Table 7 summarizes the applied methodologies. As an emerging theoretical stream, EEs have been studied through qualitative methods. Thus, several articles use a case study technique. There is an increase on quantitative methods using factor analysis and structural equation modelling to understand variations in entrepreneurship and develop metrics. Researchers have used mixed methods, both

Table 6 The five top-cited publications

Rank	Article	First author	Journal	Year	Total citations
1	Entrepreneurship and entrepreneurial ecosystems	Malecki	<i>Geography Compass</i>	2018	185
2	Entrepreneurial ecosystems: economic, technological, and societal impacts	Audretsch	<i>Journal Technology Transfer</i>	2019	111
3	The ecosystem as helix: an exploratory theory-building study of regional co-opetitive entrepreneurial ecosystems as Quadruple/Quintuple Helix Innovation Models	Carayannis	<i>R&D Management</i>	2017	110
4	A social capital approach to the development of sustainable entrepreneurial ecosystems: an explorative study	Theodoraki	<i>Small Business Economics</i>	2018	83
5	Connecting local entrepreneurial ecosystems to global innovation networks: open innovation, double networks and knowledge integration	Malecki	<i>International Journal of Entrepreneurship and Innovation Management</i>	2011	83

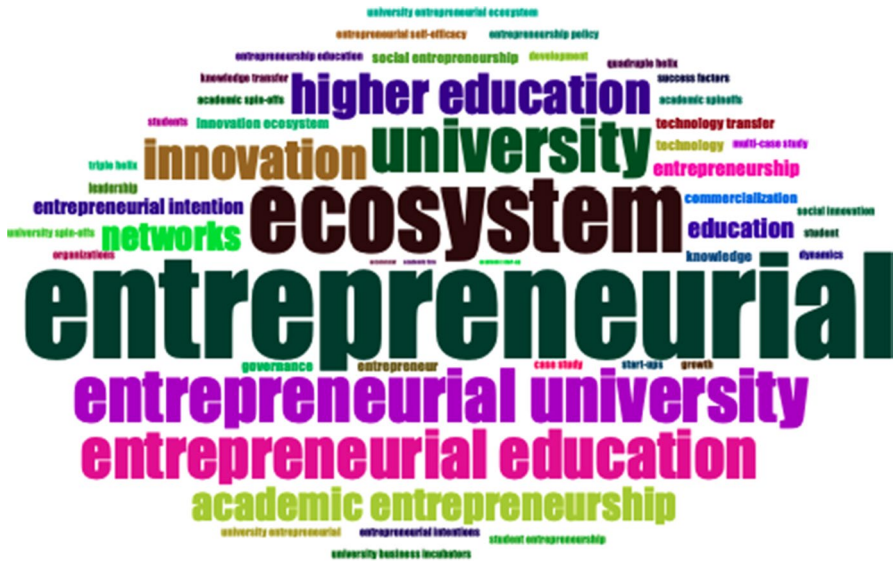


Fig. 2 Most mentioned keywords

qualitative and quantitative data collection techniques to address the complexity of the phenomenon.

Concerning methodologies, of a total 110 articles, 59 documents (54%) use a qualitative approach, through the technique of data collection via interviews (in-depth and semi-structured), samples, observation and documentary analysis. The case study technique, inserted in this approach, focuses on 25 articles, meaning that its weighting is 42% in relation to the total number of articles that use qualitative methodologies. The 28 articles (around 25%) use a quantitative approach through data collection techniques involving the application of questionnaires and secondary data (statistics) and eight articles (7%) use mixed methods, namely, they use both qualitative and quantitative data collection techniques. Eight conceptual articles (7%) and seven literature review articles (6%) were identified. Of this literature review, five are based on systematic literature reviews. From the numbers, we deduce that there is no balance of methods in EE and HEI studies and literature reviews are the least frequent type of publication.

Thematic Analysis

In this part of the article, the thematic analysis results will be examined. It will start with the strategic and evolutionary analysis and, subsequently, the networks created by the co-citation analysis. The subsequent figures will be presented all results.

Table 7 Methodologies in AEE research

Number of articles	Percentage	Methods	Examples
59 (25)	54% (42%)	Qualitative methods (case study)	Allahar and Sookram (2019); Audretsch et al. (2019); Carayannis et al (2017); Malecki (2018); Theodoraki et al. (2018)
28	25%	Quantitative methods	Audretsch and Belitski (2017), Audretsch and Link (2017); Hallam et al. (2017), Pita et al. (2021); Prokop and Thompson (2022)
8	7%	Mixed Methods	Breznitz and Zhyang (2019); Johnson et al. (2019); Liguori et al. (2019)
8	7%	Conceptual articles	Colombo et al (2019); Feldman et al. (2019); Huang et al. (2020)
7	6%	Literature reviews	Hayter et al. (2018); O'Brien et al. (2019); Kamsheba and Wald (2020)
Total: 110	100%		

Strategic and Evolutionary Thematic Analysis

The strategic diagram for the studied subject is presented in Fig. 3. The size of the circles represents the number of occurrences of these words. The upper right quadrant represents the main themes, and the upper left quadrant depicts the more specific themes, considered niche themes. The lower right quadrant represents the basic themes, and the lower left means that the theme may be emerging or disappearing.

The themes in the upper right quadrant are “academic entrepreneurship” and “entrepreneurial”. All these sets of themes are crucial to the research in this paper.

The theme in the upper left quadrant is “start-ups”, “case study” and “networks”.

The lower right quadrant represents the basic themes necessary for understanding the present study: “entrepreneurial ecosystem”, “entrepreneurial education”, “entrepreneurial university”. Also “university” and “technology transfer” are essential for the understanding on the topic. The lower left quadrant given the inexistence of declining themes but also gives the emerging themes, “entrepreneurial education” and “entrepreneur”. All this fact enhances the importance of the sets of themes in the article.

Thus, “networks”, “case study” and “academic entrepreneurship” reveal themselves as major themes. The transversal themes are “entrepreneurial ecosystems” and “university incubators”. This last phase, 2022, was the growth stage of an approach integrating Entrepreneurial Ecosystems and the Entrepreneurial

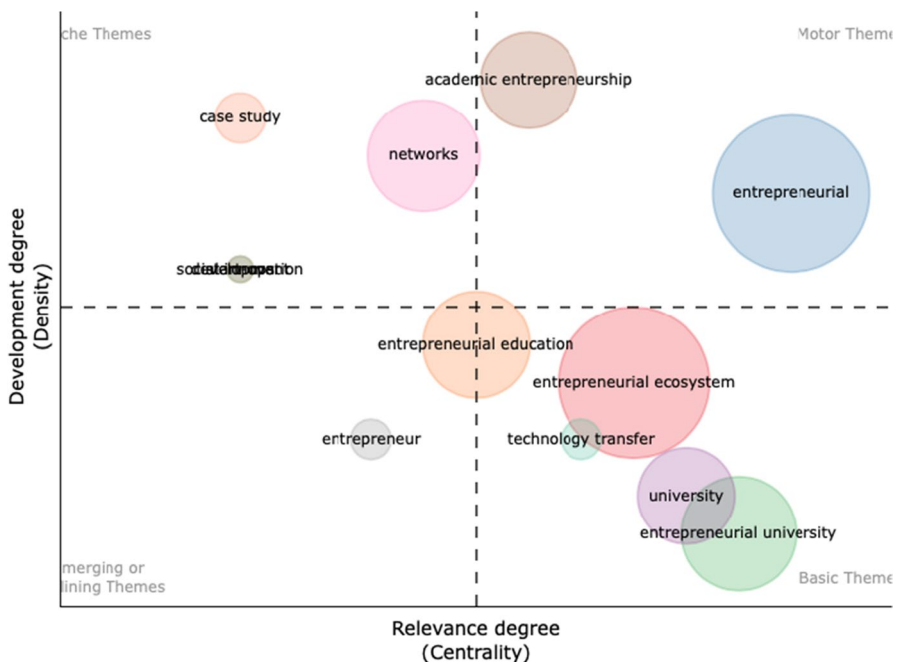


Fig. 3 Strategic diagram

University. Therefore, 2023 could be a high growth phase for an integrated approach to AEEs.

Figure 4 presents the evolution of research topics in entrepreneurial ecosystems and the relationship with the university. The data were analysed using the author’s keywords and cut-off points in the years 2014, 2018 and 2020. The results reveal a thematic evolution of the conceptual frameworks from 2011 to 2022. From the general concept of “Entrepreneurial Ecosystem” (2011–2014), “innovation” emerges in the thematic evolution (2015–2017). Therefore, the cut-off points were two periods when the first publications on the topic of the paper appeared (three publications in 2011–2014 and nine publications in 2015–2017).

In 2018, results of the emergence of thematic areas such as “education” and “higher education” are revealed. From 2019, “entrepreneurial ecosystem” gives way to “entrepreneurial education”, “entrepreneurial university” and its “ecosystem”. Likewise, the area of “innovation” gives way to a unique “entrepreneurial ecosystem” based on “entrepreneurial education”, “university”, “higher education” and “academic entrepreneurship”. The thematic evolution of the conceptual framework between 2018 and 2022 revealed that these periods are the most productive and creative with the highest number of base themes and driving themes evolving in these periods.

Cluster Analysis

A bibliometric analysis was carried out to understand how this field of study is divided into research clusters, and the co-citations were analysed. No cut-off point for the number of citations per document has been defined. All linked documents

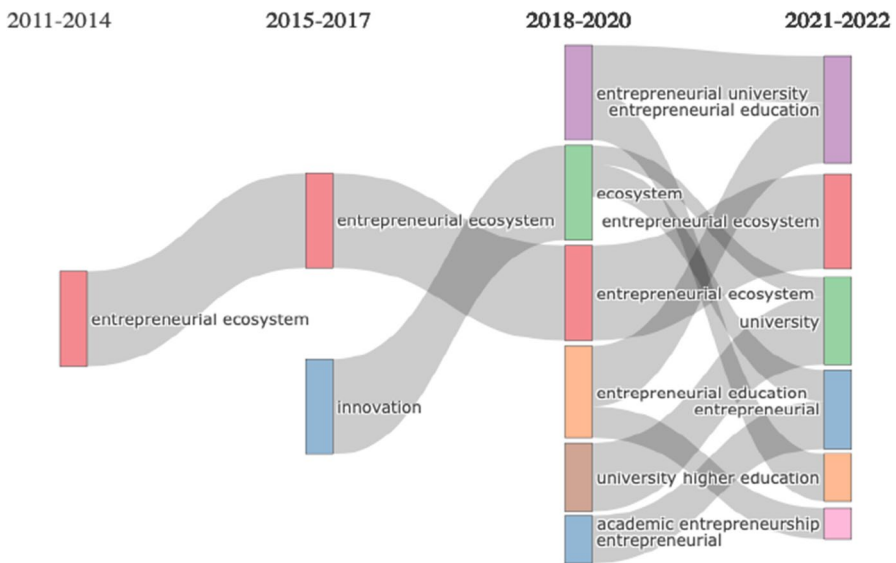


Fig. 4 Thematic evolution, with cut-off points

were selected, leaving us with a final analysis with 50 documents distributed by clusters. Each of the clusters, identified with different colours, can be observed in Fig. 5. The colours indicate the clusters and the articles belonging to them. In addition, each article's weight is assigned based on the links' total strength, and the number of citations the publication has received. The top nodes are the publications with the highest link strength.

Based on the visualization of Fig. 5 and after analysing the resulting network and the content of the articles, it is concluded that the research is divided into three thematic clusters (Table 8).

Cluster 1 (Blue)—Conceptualization and Attributes of Entrepreneurship Ecosystems The first cluster is focused on the definition and attributes present in EEs. No consensus has been reached in the academic community on the theoretical characterization of the concept and the elements that characterize it.

While there is none accepted definition of an EE, as Spigel (2018) points out, the most active area of interest has been around the types of domains (Isenberg, 2010, 2011), components (Cohen, 2006) or attributes (Spigel, 2017).

Diverse literature provides tools that show several factors considered important for a successful EE. Cohen (2006) refers to formal and informal networks, government, university, skilled human resources, support services, funding and talent. The works of Isenberg (2010, 2011) list six domains present in the ecosystem: policy, funding, culture, support, human capital and markets.

Spigel (2017) efforts to rank the categories of an EE in terms of (i) cultural attributes (entrepreneurship stories, supportive culture), (ii) social attributes (talent,

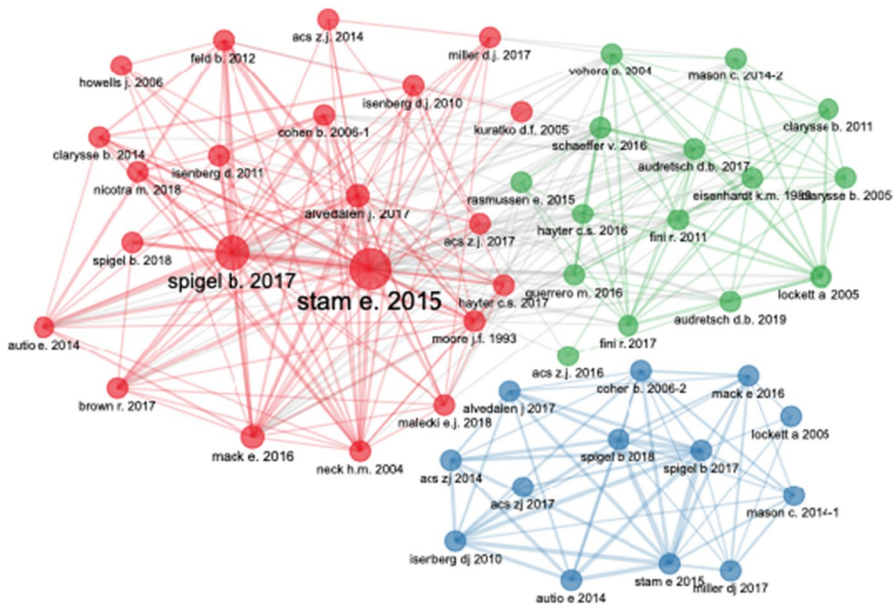


Fig. 5 Clusters networks through the co-citation analysis technique

Table 8 Clusters according to content analysis of the authors

Clusters	Main theme	Sub-themes	Publications with higher link strength	N° of publications
1-BLUE	Conceptualization and attributes of EE	“definition” “elements” “cultural” “social” “material”	Spigel (2017)	13
2-RED	Spatial context and knowledge ecosystems	“context” “dynamics” “knowledge” “value creation”	Stam (2015)	22
3-GREEN	Inter-institutional relationships in University’s Eco-system	“Triple Helix Model” “third mission” “clusters” “spinoffs” “TTO”	Audretsch et al. (2019)	15

In clusters 2 and 3, although all publications have the same link strength. but the authors Spigel (2017) and Audretsch et al. (2019) are the most cited

mentors, networks, investment capital) and (iii) material attributes (infrastructure, universities, support services, public policies, open markets). Spigel and Harrison (2018) give attention to several factors such as governance, knowledge, industry, actors, resources and benefits.

Table 9 summarizes the attributes by applying them to the EEs.

Although the topic on the attributes of EEs is innovative, it has not been without trials. Several articles highlight criticisms of previous work (Alvedalen & Boschma, 2017; Brown & Mason, 2017; Malecki, 2018; Nicotra et al., 2018; Stam & Spigel, 2017). Alvedalen and Boschma (2017), Nicotra et al. (2018) and Stam and Spigel (2017) highlighted the lack of a clear analytical framework to empirically explain the cause-effect relationship of EEs’ attributes and their effects on productive entrepreneurship. The static approach of EE studies was another criticism highlighted as its evolution over time was not considered. Finally, Malecki (2018) noted the lack of an issue related to spatial scale.

Cluster 2 (Red)—Spatial Context and Knowledge Ecosystems Beyond definitional debates, the lead author of this cluster, Stam (2015), expresses himself critically concerning studies of EEs. He underlines that it is not only generating entrepreneurship that makes it a good EE. He also mentions that the approaches only offer a long list of elements without a cause-effect relationship and concludes that it is unclear what level of geographical analysis the approaches have taken into consideration. The author refers that a new emerging approach to EE occurs, conveying a new view on people, networks and institutions. From this emerging approach, differentiations have emerged at two levels: spatial context and dynamics of knowledge ecosystems.

The first sub-division of this cluster refers to the importance of context in EEs (Acs et al., 2014; Cohen, 2006; Spigel, 2017; Stam, 2015). For Stam (2015), the

Table 9 Attributes of entrepreneurship ecosystems

Attributes	Application to entrepreneurship ecosystems	Authors
Cultural	These characteristics help ensure a steady flow of new entrepreneurs and further legitimize the status of risk takers within a region's culture	Cohen (2006); Isenberg (2010, 2011); Spigel (2017)
<ul style="list-style-type: none"> • Attitudes • History 		
Social	Internal social networks create a flow of knowledge that allows entrepreneurs to obtain sources of information that would not otherwise be accessible	Cohen (2006); Isenberg (2010, 2011); Spigel (2017)
<ul style="list-style-type: none"> • The networks themselves • Investment capital • Mentors • Workforce 	<ul style="list-style-type: none"> • The presence of local investors deeply connected to the local business community is necessary to catalyse the growth of entrepreneurial businesses • Mentors help entrepreneurs develop new skills and build their own social capital • Technical workers as well as more experienced managers can help entrepreneurs as businesses grow and mature 	
Material	They have a tangible presence in the ecosystem	Cohen (2006); Isenberg (2010, 2011); Neck et al. (2004); Spigel (2017)
<ul style="list-style-type: none"> • Universities • Support services • Governance and policies • Open markets 	<ul style="list-style-type: none"> • Universities develop technologies and the human capital of a region • Support services and facilities provide expert assistance to companies • Policies materialize through government rules and regulations 	

Source: Adapted from Cohen (2006), Isenberg (2010, 2011), Neck et al. (2004) and Spigel (2017)

common denominator in this sub-cluster seems to be that entrepreneurs create value in a specific institutional context. The author approach emphasizes the interdependencies within the context and provides a bottom-up analysis of the performance of regional economies. Stam (2015) argues that EEs open the door to a shared responsibility among actors that foster, encourage and support entrepreneurs, asking about the systemic services that a region tries to achieve.

The second sub-cluster analyses the dynamics of knowledge ecosystems, namely, the role of HEIs for value creation in a given context. Kuratko (2005), in his study, notes that younger people have become the most entrepreneurial generation since the Industrial Revolution. The growth and development in programmes and curricula dedicated to entrepreneurship and the creation of new projects have been remarkable. The number of colleges and universities offering entrepreneurship-related courses has increased. However, among this enormous expansion, for Kuratko (2005) there remains the challenge of the academic legitimacy of entrepreneurship. Although there has been this significant growth, the author points out two specific challenges to academia: (i) development of academic programmes and specialized human resources to improve the quality of courses and (ii) commitment by institutions to create formal academic programmes.

Clarysse et al. (2014) analysed the tension between knowledge and business ecosystems. In relation to the success factors, they seem similar: diversity of organizations and key actors. However, regarding the factors, anchor organizations in knowledge are universities and public research organizations that do not directly compete with the ecosystem. In contrast, key actors in EEs are based on companies that are competitors in the ecosystem. Another difference lies in value creation. In knowledge ecosystems, to Clarysse et al. (2014), the value creation flows from upstream to downstream, while in EEs, the value creation process is non-linear. The author's note that some studies already include universities as part of the knowledge system but that further research could focus on analysing the circumstances under which a university could be considered an ecosystem and how the interaction between knowledge and business ecosystems would occur. Miller and Acs (2017) explore the EE of higher education by choosing a university campus because the "entrepreneurial opportunities had been identified and/or the process of firm-formation had begun by multiple founders..." (p. 82).

Cluster 3 (Green)—Inter-institutional Relationships in University's Ecosystem This third cluster leads us to the wider set of relationships in the university's ecosystem, strategies and their specificities of regional/local factors. Audretsch et al. (2019) refers that EE is a vehicle for carrying entrepreneurs, policymakers and managers of linked companies and all their relationships organizing the EE. For the author, an EE is defined by frontiers, and the necessary resources are produced and absorbed within and beyond those boundaries.

Audretsch and Belitski (2017) set out to develop a model that captured both regional and local systemic factors to better understand and explain variations in entrepreneurial activity. In their study, they found four domains under EEs in European cities: norms and culture, infrastructure and equipment, formal institutions and Internet access and connections. To Audretsch and Link (2017: 431), conceptually a

university represents a “reservoir of knowledge, knowledge embodied in faculty...”. Universities are one part of the complexity of the research. They have evolved towards taking an active role in regional development and the dynamics of local networks. This evolution in the model involves inter-institutional relationships between the three actors, leading to an increasing overlap of their roles. The work of Schaeffer and Matt (2016) showed that universities cannot replicate the mechanisms that lead to the success of an EE but rather adapt their strategies to the specificities of each regional context.

Can academia encompass a third mission, beyond research and teaching? This question was formulated by Etzkowitz and Leydesdorff (2000: 110). Three spaces emerge from the triple helix model: the consensus space, a knowledge space (R&D activities) and innovation space.

Schaeffer and Matt (2016) state these are coordinated and managed by a regional innovation officer. The authors refer that this responsibility can be assigned to the university to contribute to developing the regional networks. They analysed the university of Strasbourg’s Technology Transfer Offices (TTO) and supported entrepreneurial academic activities over 15 years. The study reveals a strong growth in the structure of the TTO and its role as a boundary, changing objectives and developing collaborations with other regional actors. As pointed by Fini et al. (2011) and Vohora et al. (2004), since university faculty have limited entrepreneurial experience, networks with outside contacts are crucial to motivate the creation of entrepreneurial activities as well as their success.

In addition to TTOs, entrepreneurship education, either as part of the academic programme or as an extra-curricular offering, can provide students and faculty with important knowledge to stimulate and support entrepreneurial efforts (relationship to Cluster 2). While most of the study streams have focused on the role of faculty as academic entrepreneurs, Boh et al. (2016) focused on the role of students. The typology created by the authors provides insight into the various responsibilities of students and faculty in technology commercialisation. It is the different relationships between students, faculty and entrepreneurs and the analysis of the strengths and weaknesses of each that can lead to the creation of a successful spinoff. The authors, Boh et al. (2016), group into six the university practices, independent of the TTOs: project disciplines for technology commercialisation, mentoring programmes, incubator programmes, entrepreneurial business plans and entrepreneurial education for students and university professionals.

Other authors analyse the relation between social networks and academic entrepreneurship (Clarysse et al., 2011; Fini et al., 2011; Vohora et al., 2004), Spinoffs (Lockett & Wright, 2005; Fini et al, 2011, 2017; Vohora et al., 2004; Clarysse et al., 2011; Hayter, 2016) and the entrepreneurial environment and academic programmes supporting entrepreneurship (Fini et al., 2011). As pointed by Fini et al. (2011) and Vohora et al. (2004), since university faculty have limited entrepreneurial experience, networks with outside contacts are crucial to motivate the creation of entrepreneurial activities as well as their success. Vohora et al. (2004) argues that networks are pathways through which access to opportunities will be achieved, for example, gaining knowledge of the market that motivates the creation of the spinoff. Hayter (2016) uses Vohora et al. (2004) qualitative model of entrepreneurial development

and that includes four stages of development: opportunity recognition, commitment, credibility and sustainability, as well as the resources and network elements associated with each stage. Entrepreneurial development and its success are reflected in the progression of the university *spinoff*, overcoming the obstacles of each stage, with the aim of achieving entrepreneurial sustainability.

Hayter (2016), using mixed methods, compares the composition and contribution of social networks among entrepreneurial academics and analyses how these networks relate to the development trajectory of university *spinoffs*. The traditional definition of *spinoff*, according to Hayter et al. (2017) focuses on the role of faculty establishing a company based on a technology licensing agreement, with their home university. University *spinoffs*, for Hayter (2016), are an important vehicle for generating productivity, job creation and prosperity for regional economies. The author also mentions that *spinoffs* are a window through which the contributions of universities can be examined. He compares the composition and contribution of social networks among entrepreneurial academics and analyses how these networks relate to the development trajectory of university *spinoffs*.

Cluster Relations

The three clusters are related. The cluster 2 indicates the importance of higher education for EE and cluster 3 leads us to the triple helix model with the focus on university entrepreneurial experience. Cluster 1 introduces definitions and attributes necessary to understand the EE and their relationship with or within the HEIs. This cluster creates a theoretical background with relevant publications in entrepreneurship research.

Clusters 2 and 3 have a robust relation. Notably, the position of Stam (2015) and Spigel (2017) influences 2 clusters, indicating higher link strength and confirming its centrality in the EE literature. Various articles from cluster 2 criticize the analytical framework that produces long lists of factors that enhance entrepreneurship. Their perspective enables researchers to measure an EE within a country or territory by considering their specificities. This understanding highlights the configuration, structure and evolution of ecosystems influenced by ecosystem process and territorial boundaries.

In cluster 3 it is evident that the challenge of the third mission that academia encompass emphasizes entrepreneurship and the corresponding emergence of the entrepreneurial university. The relationships between students, faculty and entrepreneurs and the analysis of the strengths and weaknesses of each can lead to the creation of a successful spinoff.

To understand the substance of AEE and how the broad research was advanced, the group of these three clusters creates a fundamental and theoretical base to: the terminology of EE, the higher education context and the emergence of an AEE (Fig. 6).

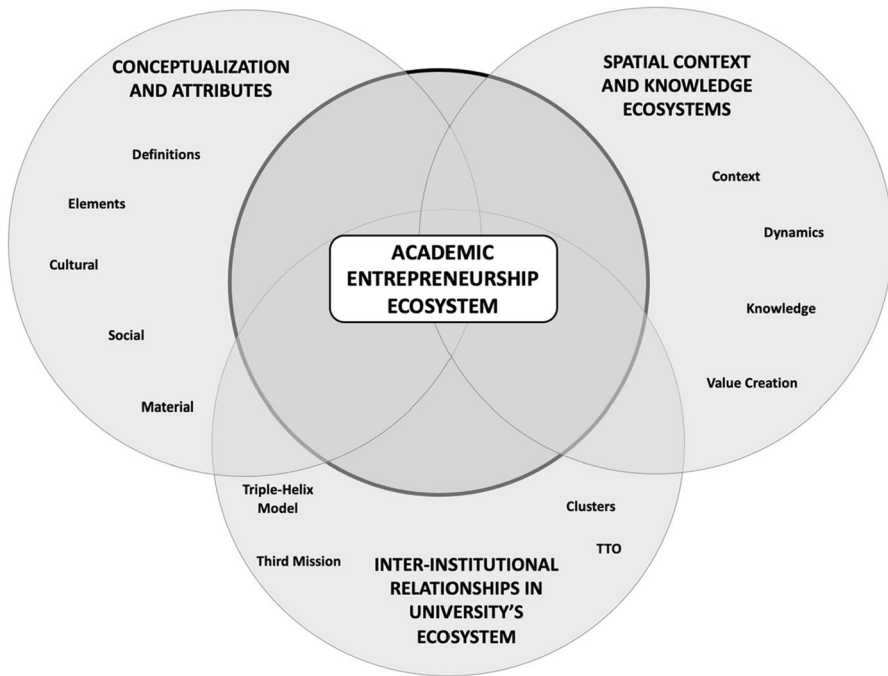


Fig. 6 Academic entrepreneurship ecosystem model

Contributions and Future Research Directions

The scientific literature about entrepreneurial ecosystems has been growing, and within it, one area that has been gaining impulse has been the academic ecosystem. This paper contributes by attempting to consolidate the most important of this growing literature and to try to confirm it.

This study brings important theoretical contributions to the existing literature. Firstly, this study led to a survey and mapping of the main investigations on EE and their relationship with the HEI. Secondly, this study strengthens the credibility of the AEE theoretical frameworks in lending support to the importance of analysing the specific contributions of HEIs to the development of an EE. Thirdly, the developed co-citation analysis allowed obtaining an understanding about the existing field of knowledge on EEs and AEE, identifying their scientific origins and revealing research roots.

Most contributions are conceptual providing an understanding of the different elements that form conducive AEE. Therefore, as a fourth contribution, this study emphasizes the need for more empirical research, especially regarding potential causal relations between elements, context factors, outputs and outcomes of entrepreneurial ecosystems. The few empirical studies on entrepreneurial ecosystems have majorly applied case studies including qualitative methods (Kansheba & Wald, 2020; Malecki, 2018; Nicotra et al., 2018). There is a need of deploying other methodological approaches for more rigor and generalizability purposes.

The above leads us to propose as possible future research directions. As mentioned, most research studies on EEs and AEEs have adopted the qualitative methodological approach (particularly case studies), which is understandable since the research topic is emergent. However, considering the systematic research conducted here, it is believed that this topic would benefit from implementing mixed methodologies (as has already been carried out by some of the authors included here). Thus, with the adoption of qualitative and quantitative methodologies, it will be attempted, in a future line of research, to build an assessment tool for an AEE.

The composition of clusters groups generated research points. Studying an AEE based on a regional scale will imply, firstly, building a theoretical framework, based on multiple dimensions, which allows the development of the EE model. HEIs are a complex process which involves an extensive research approach to accurately represent the levels and components of the entire entrepreneurial ecosystem (cluster 1). It will be necessary to study whether the HEI develops strategies adapted to the specificities of its EE. Likewise, to explore the pillars of the model from the point of view of young university students who show varying degrees of entrepreneurial intention (cluster 2). Several studies have found that entrepreneurship education has a positive impact on students' entrepreneurial intention (Peterman & Kennedy, 2003; Souitaris et al., 2007; Pruett et al., 2009; Engle et al., 2010; Lanero et al., 2011; Sanchez, 2013; Bae et al., 2014; Sansone et al., 2021). Vanevenhoven (2013) and Fiore et al. (2019) have warned of the need for more research into the impact of entrepreneurship education on students in different contexts. Although there has been a growing number of publications on the role of intentions in the entrepreneurial process (Liñán & Fayolle, 2015; Ferreira-Neto et al., 2023), there is still a gap in research on how to improve the presence of higher education students in entrepreneurial activities so that they can face the problems of the labour market. A broader study could be undertaken, from a mixed approach, to establish mechanisms to collect appropriate data and to establish the different levels of success of EE outcomes, by the HEI (cluster 3).

Finally, the relevance of knowledge of skilled people has brought to the policy agenda of governments worldwide the need to modernize science and higher education systems and institutions (Santos et al., 2016; Scott, 2000). Portugal is characterized as a developed country but with a poorly qualified workforce in European average terms, facing structural barriers to economic growth (Carneiro et al., 2014). It was also a country that has seen one of the fastest developments in its scientific system at the beginning of the twenty-first century (Heitor et al., 2014). The emergence of the COVID-19 pandemic has brought new challenges to the country: the establishment of telework and the intense decline in economic activity were some of the most evident cross-cutting changes, with direct consequences for the emergence of new forms and policies to support the employment (Sousa & Paiva, 2023).

All these reasons have been supporting the need to make a RSL focused on how young graduates capture new forms and conditions of the exercise of work. This knowledge is crucial to investigate how the entrepreneurial skills or the academic entrepreneurship path is in the future.

Conclusions and Limitations

The quest to identify and define EEs has become an issue of great importance as countries, regions and cities handle with an entrepreneurial economy. The range of these topics is wide and ambiguous. Researchers and practitioners have assessed various contributions, most of which identify HEIs as important development institutions. Marques et al., (2021: 133) highlight their importance, stating that HEIs "... are seen as organizations responsible for human resource training, knowledge transfer, and regional development".

This work used data from the Scopus and WoS databases. Based on 110 academic articles obtained through a rigorous data collection process, the study went beyond describing elementary information, standing out in relation to the review studies found and filling a gap in the field of EEs taking into consideration higher education institutions. It also revealed the embryonic state of research (2011–2022) and reinforced the scientific importance of the topic since about 56% of the articles were published in the last 3 years. The results were published in a variety of indexed journals. However, this study shows the limitations in other literature reviews.

Despite considering that this study constitutes a work that will be the object of the development in the coming years, the study is not without limitations. The first limitation concerns to the search strategy. This study is based on the regular updating of databases with the consequent increase or decrease in the number of indexed journals, so a bibliometric analysis of an emerging topic can be subject to substantial variations in just a very few years. The other limitation of this study is that it used two different databases to analyse a particular topic. Despite being two of the most influential databases, the overview could be improved by including other databases. Another limitation is the subjectivity present in the scientific articles analysis. Although bibliometric methods help to reduce subjectivity, it is not possible to completely exclude some interpretative biases.

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Data Availability Available upon reasonable request from the corresponding author.

Declarations

Conflict of Interest The authors declare no competing interests.

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