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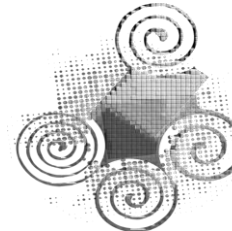
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INTERNATIONAL SCIENTIFIC PRODUCTION IN ENTREPRENEURIAL, INNOVATIVE AND BUSINESS ECOSYSTEM: FRONTIERS AND TENDENCIES

PESQUISA INTERNACIONAL EM ECOSISTEMA EMPREENDEDOR, INOVADOR E EMPRESARIAL: FRONTEIRAS E TENDÊNCIAS

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Abstract

This paper aims to analyze how the studies regarding entrepreneurial, innovative and organizational ecosystems are set, establish what theoretical connections exist, and build a future agenda. As for the methodology, the study carried out a bibliometric research. The database was collected from the Web Of Science. The results suggested that: the publications and citations have been considerably expanding since 2014; the debate prevailed in China and the United States of America; the papers show inter and multidisciplinary characteristics; in the field, prevailed the texts that study the entrepreneurial ecosystem and seek to deepen the concepts and analysis.

Keywords: Entrepreneurial Ecosystem. Innovative Ecosystem. Business Ecosystem. Bibliometric Analysis. CiteSpace.

Resumo

O trabalho tem como objetivo analisar como se configura o campo dos estudos acerca dos Ecossistemas Empreendedor, Inovador e Empresarial, os quais estabelecem relações teóricas, e construir uma agenda futura. Como metodologia foi realizado um estudo bibliométrico. A base de dados foi coletada a partir da Web Of Science. Os resultados sugeriram que: as publicações e as citações vêm se expandindo consideravelmente a partir de 2014; o debate predomina na China e nos Estados Unidos; os trabalhos possuem característica inter e multidisciplinar; no campo predominam os textos que estudam o ecossistema empreendedor e tentam aprofundar os conceitos e análises.

Palavras-chave: Ecossistema Empreendedor. Ecossistema Inovador. Ecossistema Empresarial. Análise Bibliométrica. CiteSpace.

Introduction

The competitive environment, in which the organizations operate, goes through fundamental transformations regarding the interactions. The most traditional markets have been turning into networks. These changes demand approaching a wider context and deeper network of suppliers, research and development (R&D), and competitive coalitions (Möller & Halinen, 1999), in the interaction between the organization, its clients, suppliers and other economic actors. According to Aarikka-Stenroos and Ritala (2017), this transition stimulates greater connectivity, interdependency and coevolution of actors, technologies and institutions, therefore demanding theoretical and empiric approaches different from the ones frequently practiced in interaction and network studies.

The ecosystem approach reveals a new way of looking at the structure, interaction and exchanges between the organizations (Anggraeni, 2007), and it has been gaining awareness in research, reflecting an increase in the number of publications about ecosystems in the business context (Cavallo, Ghezzi & Balocco, 2019; Dedehayir, Mäkinen & Ortt, 2018; Adner, 2017; Ansari, Garud & Kumaraswamy, 2016). These researches include disciplines of strategic management (Adner, 2017; Ansari, Garud & Kumaraswamy, 2016), innovation, and technology management (Clarysse *et al.*, 2014; Gawer & Cusumano, 2014; Ritala *et al.*, 2013).

To reach and enlighten conceptually the groups of actors, institutions, social structures and cultural values that form the economic activity (Thomas & Autio, 2012; Tsujimoto *et al.*, 2015; Hakala *et al.*, 2019), some researchers adopted flexibly the business, innovation and, recently, the entrepreneurial ecosystem metaphor concepts (Adner, 2017; Adner & Kapoor, 2010; Hakala *et al.*, 2019). Although they are essential to the conception of social realities and collaborate with our experiences' senses (Musolff, 2012), metaphors may also be the basic way of thinking in which scholars conceptualize and tell a phenomenon's story (Haslam, Cornelissen & Werner, 2017). As a result, a thoughtless application of the ecosystem metaphor increases the risk of it being vague and confusing, undermining the credibility and the explanatory power of the ecosystem concept (Kuckertz, 2019; Thomas, Sharapov & Autio, 2018; Hakala *et al.*, 2019).

Moore (1993) first proposed the “ecosystem” concept applied to the organizational context, from the adaptation of a biological concept, more specifically from ecology. He adopted the “organizational ecosystem” as a metaphor to represent the interdependency and coevolution that characterize contemporary organizational activities. Throughout time, the concept has gained attention and a range of labels, which seek to learn the nature of this approach, adopted it (Aarikka-Stenroos & Ritala, 2017). This includes, besides the “business ecosystem” concept, conceptualizations such as “innovative ecosystem” (Adner & Kapoor, 2010) and “entrepreneurial ecosystem” (Cohen, 2006; Isenberg, 2010), objects of study in this paper.

In summary, the evolution of the ecosystems approach developed from three generations: the first generation oriented by the actors that conducted the business ecosystems; followed by the second generation that looked at communities and self-organized social movements, and, lastly, a third generation that sought a wider way to combine both elements (Moore, 2013). According to Moore (2013, p. 3), this ecosystem approach makes it possible for studies to analyze “a new way of organization”, seeking to reach shared purposes and obtain benefits for a variety of people, cultures and problems, which stands out in comparison to previous systems.

It is necessary to analyze what is in the literature, since it regards a field of study in-construction, and, according to what is pointed out by Hakala *et al.* (2019), there is a risk of a vague and confusing application. This way, we seek to describe simultaneously the tendencies and connections between the fields of study: Entrepreneurial Ecosystem (EE), Innovative Ecosystem (IE) and Organizational Ecosystem or Business Ecosystem (BE). We are widely based on the works of Hakala *et al.*, (2019), in

which the authors done a recurring analytic review on the concepts of business, entrepreneurial and innovative ecosystems.

The authors analyzed the concepts simultaneously, since, according to them, these concepts were developed in parallel, amidst the conceptual confusion that emerged due to the overlaid declarations that describe the meta-organizations among the economic actors (Tsujimoto *et al.*, 2015; Valkokari, 2015). However, the study of Hakala *et al.* (2019) does not present tendencies and connections to the EE, IE and BE fields of study. Further, Donaldson (2021) suggests a need to develop a strong theoretical base to ensure future studies remain coherent and systematically consistent, requiring theoretical-methodological contributions. Therefore, we need more reviews to map the state of the art, due to the great volume of publications nowadays.

In this context, this paper seeks to answer how the international literature in EE, IE and BE is arranged. Thus, its specific aims are: to examine how the international literature is arranged on EE, IE, and BE, mainly in what refers to authors, countries, references and keywords, among other elements, and elaborate a future study agenda. To that effect, the research carried out a bibliographic review, which uses quantitative techniques to examine the already established field of scientific production.

Theoretical foundation: Establishing connections between concepts

To Aarikka-Stenroos and Ritala (2017, p. 2), the key to the ecosystem approach is that the focal set of actors (organizations, products, among others) is examined as part of a wide and interdependent system environment. Since we can understand the ecosystem concept in different ways, the authors define the starting point as “a coevolutionary business system of actors, technologies, and institutions”. Actors include clients, consumers, user community, developers, research organizations and competitors in the entire value chain (Adner & Kapoor, 2010), as well as institutional actors (Koskela-Huotari *et al.*, 2016). Understanding technologies as multiple types of platforms and technological structures shared by the actors in the ecosystem (Eloranta & Turunen, 2016). Lastly, the institutions are regulators, policymakers and relevant interest groups, as well as cultural and national contexts under which the institutions operate (Ansari *et al.*, 2016; Aarikka-Stenroos & Ritala, 2017). Thereby, and as far as there is an increasing interest in EE, IE and BE, this fact makes it possible to assume it is a new theme based on intellectual traditions, which may vary between clusters, innovation systems and urban economy (Acs *et al.*, 2017; Brown & Mason, 2017; Malecki, 2018; Wurth; Stam & Spigel, 2021).

According to Wurth, Stam and Spigel (2021), the first roots to the EE ideas are from a century ago, dating back to 1920 with Marshall, who studied the factors that stimulate the organizations in certain territories, called industrial districts. Marshall's industrial districts idea inspired later research (Krugman, 1992; Markusen, 1996), initially with seminal research about innovative national systems (Freeman, 1995; Lundvall, 1992), learning regions (Keeble *et al.*, 1999; Malmberg & Maskell, 2002) and Triple Helix (Leydesdorff & Etzkowitz, 1996). Later with wider research about regional clusters (Delgado, Porter & Stern, 2016; Porter, 1998, 2000) and regional innovative systems (Cooke, 2001; Cooke, Gomez Uranga & Etzebarria, 1997). Nevertheless, these approaches have aims, methodologies and different epistemological perspectives of the way the economy works, coalescing themselves by the fundamental understanding of the existence of elements external to the organization (groups of actors, institutions, social structures and cultural values). These external elements are present in certain regions and corroborate to the competitive advantage in the organization level (Spigel & Harrison, 2018; Wurth *et al.*, 2021).

The EE approach, although narrowly contested and defined (Stam, 2015; Malecki, 2018), embraces unique combinations of social, political, economic and cultural elements that affect entrepreneurship and economic growth (Spigel, 2017). This approach combines the regional development literature and strategic management (Acs *et al.*, 2017), connecting entrepreneurship to economic growth (Acs *et al.*,

2018; Cao & Zhang, 2021). To Stam (2015), EE is “a group of actors and factors that are coordinate and interdependent in a way that makes possible the productive entrepreneurship”.

The IE approach has its roots in BE (Moore, 1993), which has its origins in the ecology concept (Ferasso *et al.*, 2018) and the national innovation system (NIS) (Freeman, 1988; Lundvall, 1992). In the past years, the use of the IE approach to study innovation has become more and more popular, since the number of studies that use this approach has increased enormously (Mikhailov *et al.*, 2021). The BE approach was introduced by Moore in 1993, who defined it as an economic community supported by a base of organizations and persons that interact — the business world organisms. This economic community produces valuable goods and services for clients that are members of their ecosystem. The member organizations also include suppliers, leading producers, competitors and other interested parties. With time, they co-evolve their capacities and roles and tend to align with the directions established by one or more central organizations (Lee; Chang & Wang, 2021).

In summary, this brief theoretical reference shows a discussion regarding the key to the ecosystem approach and the base that has enabled the development of ecosystems focused on business, introducing the EE, IE and BE to comprehend the context in which these approaches are used.

Methodologic path

This paper is characterized as a bibliometric study, and intends to describe tendencies and connections between EE, IE and BE. This type of investigation uses quantitative techniques to examine the academic production of a certain field, considering authorships, co-authorships, citations, co-citations, journals, keywords, volume of publications and bibliographic distribution (Prado *et al.*, 2016). Providing a quantitative method to review and investigate the existing literature in a certain field (Mayr & Scharnhorst, 2015), presenting the settings, the development and its path (Liu *et al.*, 2014). To research, effectively, the connections and methods used needed to be clear, so, based on this, the present paper used a framework adapted from Prado *et al.* (2016). This framework exposes certain stages to follow to do research related to data search: selection, organization and analysis of papers that will form the research *corpus*.

Moving on, we established the indexed base Web of Science (WOS - main collection), by Thomson Reuters Scientific, as a data source. The selection of only one database is justified by the standardization of the raised information. Regarding the selected base, we highlight its relevance, range and reliability (Garcia *et al.*, 2021). It is a reputable database, one of the most significant in the world since it reaches a great number of internationally well-reviewed journals, is part of several distinct fields of knowledge and has serious policies for journal inclusion and exclusion (Wang & Waltman, 2016; Duque & Cervantes-Cervantes, 2019). Moreover, the WOS base allows search and reference export to be used in the bibliometric analysis software CiteSpace (Chen, 2006; Garcia *et al.*, 2021), that will be used in this research. CiteSpace enables the elaboration of what Chen (2006) calls the Research Front (the most cited papers in a specific field and its settings), as well as the Intellectual Base (scientific literature citation and co-citations). Both concepts are relevant to analyze tendencies and patterns in a determined knowledge field, and to detect emerging themes (Chen, 2006). The basic research variables are described in Frame 1:

Frame 1. Search criteria synopses

Search Systematization	Filters
(a) Search field	((TI= (“entrepreneurial ecosystem”)) OR TI= (“innovat* ecosystem”)) OR TI= (“business ecosystem”)
(b) Type of document	Papers
(c) Web of Science category	All categories
(d) Stipulated time	1991-2022
(e) Search date	March 14, 2022

Source: Self-authorship.

Thus, to execute the search, the terms used were “*entrepreneurial ecosystem*”, “*innovat* ecosystem*” and “*business ecosystem*”, in between quotation marks to find the complete terms. The terms should be on the papers’ titles. The search included all years from the database up to March 2022, all languages and categories, and used a filter that included only scientific papers, disregarding other types of productions — this was used because scientific papers are blindly reviewed by peers. By the end of the filtering process, 622 papers were available. Following the used framework and the CiteSpace analysis, the papers’ references were downloaded and exported in two formats: spreadsheet and text (Chen, 2006; Prado *et al.*, 2016). Throughout the whole process, the data structuring and systematization happened.

After searching for the information in the Research Front analysis, the study analyzed the 622 articles. This investigation includes the evolution and tendency of the publications by year, which seeks to verify the behavior of the publications in time, aiming to identify the start and possible increasing and decreasing movements of the publications. In addition to this, we also considered in the investigation the frequency of publication by country, the co-authorship between countries, and the countries holding the greater centrality. It is relevant to highlight that, according to Garcia *et al.* (2021), the co-authorship consists of the partnership between authors from different nationalities, and the centrality regards the number of partnerships a certain country performs with other nationalities.

Still in the Research Front, the frequency of publications by journals and their respective impact factors (these factors are collected in the WOS itself), and the analysis of co-occurrence and keyword citation bust, were analyzed. The co-occurrence is based on the *Author Keywords* (when a paper uses the keyword) and on the *Keyword Plus* (when an established keyword is used frequently on the paper’s referenced publications titles). The keyword citation bust are the terms that occur in a great number of co-occurrences in a specific journal (Garcia *et al.*, 2021). The main collection categories of the database were analyzed to verify in which category each production was indexed (WOS). Regarding one of the most relevant analysis from the Research Front, the central papers were obtained considering the number of citations of the papers. This analysis enables us to determine the papers that represent the main themes researched by the field. At this stage of operationalization, the information regarding the number of citations raised in the WOS was analyzed, and a summary of the papers was presented. Finally, the research analyzed the most cited papers by area. These papers may indicate relevant themes for the field, and point to possible research tendencies, in addition to pertinent definitions.

Next, we intend to analyze the intellectual base, which aims to present the citations and co-citations in scientific literature, from both authors and documents (Chen, 2006). The authors’ co-citation analysis seeks to highlight authors that have been referenced by papers from the search, while the co-citation’s objective is to identify when two authors are referenced simultaneously. To Garcia *et al.* (2021), in a similar sense, the papers’ co-citation indicates the documents that have been referenced by two or more papers from the search. The Intellectual Base relevance is due to the reference analysis used by the local sample.

In the end, from the most cited and published papers from 2021 to March 2022, a future research agenda was outlined, created from the research indications pointed out in the selected papers. It becomes important to highlight that the creation of the future research agenda does not contain papers from 2021 and 2022, since not all of them presented suggestions for future research. Moreover, some papers were not available in complete. Therefore, the future research agenda focused on the 15 published papers and on the most cited papers in the selected period.

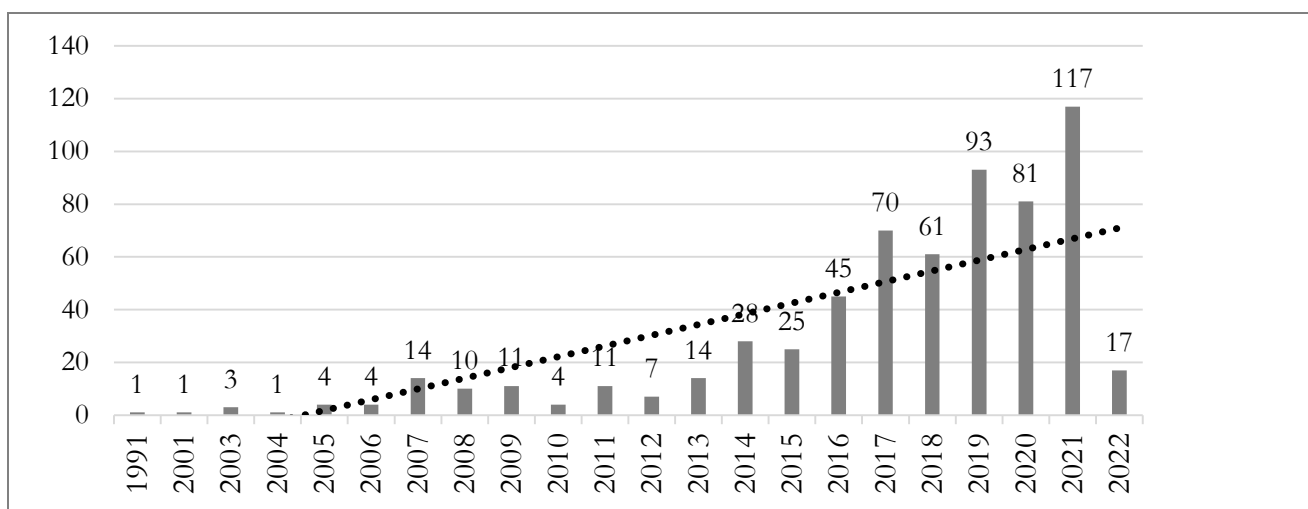
Results and discussion

The results and discussions are divided into two subdivisions, the first one exposes the Research Front analysis results, and the second shows the Intellectual Base results.

Research front

In order to present the direction of the research, we display the WOS database publications by year using a frequency chart (Picture 1), considering the 622 delimited papers that represent the field of study. Considering the period between 1991 to March 2022, it is noticed that the research about EE, IE and BE is relatively recent. While the first paper was published in 1991, the second was published only in 2001, about ten years after the first publication. In addition to that, up to 2006, the number of publications may be considered small, not different from the other years, showing rapid growth only after 2014. Starting in 2014, the number of publications went from 28 to 117 in 2021, the year with the greatest number of publications in the historical data series.

Picture 1. Productions evolution and tendencies by year (1991-2022).



Source: Elaborated with data from the *Web of Science*.

The seminal paper was published in 1991 and the title is *Applying The New Set Of Lenses - Implications For Managers Of Managing In The Business Ecosystem* (Zeleny; Cornet & Stoner, 1991). In the next 10 years, no papers were published in this field of research. In the first decades after 2001, only two texts were cited at least 50 times: *Opening up for competitive advantage - How Deutsche Telekom creates an open innovation ecosystem* (Rohrbeck; Holzle & Gemunden, 2009), with 50 citations, and *'Mode 3' and 'Quadruple Helix': toward a 21st century fractal innovation ecosystem* (Carayannis & Campbell, 2009), with 88 citations. Adding to these few publications, the papers that extrapolate over 190 citations were published only after 2018: Yang and Zhang (2021), and McMullen (2018), both with 192 citations; Nicotra *et al.* (2018) with 194 citations; Cao and Zhang (2021) with 202 citations; Wurth *et al.*, (2021) with 231 citations, the greatest number of citations in the historic series. The chart in Picture 1 teaches us that the research regarding EE, IE and BE is ongoing since the 90's, however, it has been widely approached only recently, specifically since 2014.

Continuing the Research Front analysis, Frame 2 presents the frequency of publications by country. Regarding the countries with the greater number of papers in the database, we highlight them by continent. In Asia: China with 175 published papers, starting their research in 2007; Russia with 18 published papers, starting the publications in 2012; and India, with 16 papers and other publications, starting in 2017. In North America, the United States with 65 published papers, starting in 2008. In Europe: England, Finland, Germany, Italy, Spain and France with 51, 37, 23, 20, 18 and 17 published papers, starting their publications in 2007, 2014, 2008, 2013, 2011, and 2009, respectively. In South America, there is Brazil with 23 papers, starting its publications in 2015. Lastly, in Oceania, there is Australia with 19 published papers since 2007.

Frame 2. Frequency of publications by country.

Country	Frequency	Start	Centrality
China	175	2007	0.00
USA	65	2008	0.00
England	51	2007	0.00
Finland	37	2014	0.00
Germany	23	2008	0.00
Brazil	23	2015	0.00
Italy	20	2013	0.00
Australia	19	2007	0.00
Spain	18	2011	0.00
Russia	18	2012	0.00
France	17	2009	0.00
India	16	2017	0.00

Source: Elaborated from CiteSpace.

Based on Frame 2, it is possible to learn that the representativity of developed and/or underdeveloped countries is small, to the extent that the most significant papers are concentrated, mostly, in well-developed countries. Furthermore, Picture 2 shows the co-authorship between countries. The centrality refers to the number of publications compared to the other countries. Therefore, the knot size indicates the country's centrality, the greater the knot, the greater the number of publications about the other countries. The most central countries are China, the United States, England and Finland.

Picture 2. Co-authorship network between countries.



Source: Elaborated from CiteSpace.

To analyze the association between countries, it is relevant to widen the research context. In particular, in the EE, IE and BE fields, this connection enables the structure of research that considers different behaviors and practices, since each country has its own organizational and social space.

An important analysis of the bibliometric studies is presented when we take the keywords into consideration, since they aim to exhibit the elemental approaches from a specific field. Thus, Picture 3 shows the co-occurrence of keywords, which are based on the *Author Keywords* and *Keywords Plus*. As far as the expression shows up in the *Author Keywords* and in the *Keywords Plus*, it is possible to state that there is a co-occurrence. The knot size refers to the co-occurrence frequency.

Picture 3. Keywords co-occurrence.



Source: Elaborated from CiteSpace.

When the most co-occurred keyword is analyzed, three are highlighted: *innovation ecosystem* (119 co-occurrences), followed by *business ecosystem* (118 co-occurrences) and *entrepreneurial ecosystem* (82 co-occurrences). These evidences meet the search terms. It is possible to highlight that several words related to the EE, IE and BE fields of study also arise: *innovation* (67); *performance* (66); *strategy* (64); *system* (53); *knowledge* (52); *policy* (39); *technology* (35) and *value creation* (33). Thereby, we suppose that a close relationship exists between its field of origin and relations between authors, technology and institutions.

In Picture 4, the main collection categories of the Web of Science database are presented, in this case, the CiteSpace attaches each paper into one or more subject categories, according to the journal in which it was published (Garcia *et al.*, 2021). The net in Picture 4 shows the categories with the largest number of co-occurrences. The knot size relates to the quantity of articles in each category.

Picture 4. The Web of Science database main collection categories.



Source: Elaborated from CiteSpace.

It is worth mentioning, in Picture 4, the representativity of indexed publications specifically in the Business and Economy categories. The others, in its majority, permeate categories that involve social, human and technological matters. It is important to highlight that there were no indexed papers in the Public Administration category. This fact emphasizes the importance of looking at the ecosystems through an approach that considers the Public Administration.

According to what has been mentioned, the business ecosystem approaches are formed of a dynamic community of interdependent economic actors (business people, suppliers, buyers, governments...) and the institutional, informational, technological and social contexts at a system level (Audretsch & Belitski, 2017), formed by a group of interdependent actors that, if coordinated, may promote the regional development and the economic growth. In addition to that, the Public Administration organizations, as well as the EE, IE and BE, work with multiple institutional logic and social aims.

Therefore, considering the Public Administration is extremely important.

Furthermore, when analyzing the Research Front, Table 1 exposes the 10 most cited publications from the database. It is noted that all of these publications are from the decades of 2010 and 2020 and, therefore, quite recent.

Table 1. Research Front central papers.

Title	Journal	Reference	Quote
1. <i>Toward an Entrepreneurial Ecosystem Research Program</i>	Entrepreneurship theory and practice	Wurth; Stam & Spigel (2021)	231
2. <i>Is a sustainable loop of economy and entrepreneurial ecosystem possible? a structural perspective</i>	Environment development and sustainability	Cao & Zhang (2021)	202
3. <i>The causal relation between entrepreneurial ecosystem and productive entrepreneurship: a measurement framework</i>	Journal of technology transfer	Nicotra <i>et al.</i> (2018)	194
4. <i>Coopetition within the entrepreneurial ecosystem: startups' entrepreneurial learning processes and their implications for new venture performance</i>	Journal of business & industrial marketing	Yang & Zhang (2021)	192
5. <i>Organizational hybrids as biological hybrids: Insights for research on the relationship between social enterprise and the entrepreneurial ecosystem</i>	Journal of business venturing	McMullen (2018)	192
6. <i>Clusters, entrepreneurial ecosystem co-creation, and appropriability: a conceptual framework</i>	Industrial and corporate change	Pitelis (2012)	177
7. <i>Entrepreneurial ecosystem research: present debates and future directions</i>	International entrepreneurship and management journal	Cavallo; Ghezzi & Balocco (2019)	170
8. <i>Innovation Ecosystem framework directed to Sustainable Development Goal #17 partnerships implementation</i>	Sustainable development	Oliveira-Duarte <i>et al.</i> (2021)	169
9. <i>The innovation ecosystem in rural tourism and hospitality - a systematic review of innovation in rural tourism</i>	Journal of knowledge management	Madanaguli <i>et al.</i> (2021)	162
10. <i>Entrepreneurial ecosystem and well-being in European smart cities: a comparative perspective</i>	Tqm journal	Penco; Ivaldi & Ciacci (2021)	160

Source: Elaborated from the Web of Science data.

Wurth *et al.* (2021) suggest that the EE is conceptualized in two forms: ontologically, emphasizing its “being”; and epistemologically, focusing on “how it may be known”. Ontologically, the EE is seen as something that may be constructed — an emerging organizational form — prioritizing the ontology. This strongly resonates with the entrepreneurial and sociological approaches, emphasizing how the leaders co-create entrepreneurial communities (Van De Ven, 1993), and with design science approaches that conceptualize EE as an artifact (O'Shea, Farny & Hakala, 2019). On the other hand, the epistemological view holds that economies (local, regional, national...) are always there, but their qualities, as economic systems, enable (or restrain) productive entrepreneurship to be known with adequate knowledge, including “objective” data, and subjective “local knowledge”.

Cao and Zhang understand, based on Stam (2015), that EE is “a group of interdependent and coordinated actors and factors in a form that makes possible the productive entrepreneurship” (2021, p. 4). To Nicotra *et al.* (2018), the ecosystem concept applied to entrepreneurship is related to the capacity of a territory to create a system of actors and infrastructures to support the creation and development of innovative business projects to more than just a mere construction of a network of businesses. The concept refers to a wide system of heterogenic elements.

Yang and Zhang (2021) consider the ecosystem as “the alignment structure of the multilateral set of partners that need to interact for a focal value proposition materializes”. Based on the Resource Based View (RBV), it is possible to capacitate the entrepreneurial activities and ease the startup growth, since it may need some key resources. McMullen (2018) understands the EE as a system of discovery and

search for entrepreneurial opportunities. Cavallo, Ghezzi and Balocco (2019) understand the BE as a network of interconnected organizations that, probably, operate around a focal company or platform. According to Oliveira-Duarte *et al.* (2021), the IE is a dynamic deliberate network with complex relations based on trust, value and technology co-creation, and complementary competencies. Penco, Ivaldi and Ciacchi (2021) understand that the EE, based on systemic ecological thinking, regards the interdependency of actors from a certain community, aiming to create new value. Emphasizing the interdependency between actors and factors, follows the regional development research, and the strategy literature.

It is possible to learn, from the Research Front central papers, that the studies, in general, direct their view towards contexts external to the organization, as they are present in a certain region, capture or create value, and collaborate with the competitive advantage at the company level. In a general perspective, the concept is related to the search of new opportunities and development for a certain region by the individuals, companies, and other economic actors present in the ecosystem.

Regarding the most representative journals in the Research Front, in Table 2 the research includes the journals that have published more texts referring to EE, IE and BE. To Garcia *et al.* (2021), the analysis of the most representative journals on the Research Front indicate whether a journal is referenced in a certain theme, which may indicate a possible path to search for references and publications. It is noted in Table 2 that the three most representative journals are: the *Harvard Business Review*, with 314 frequency and 6,870 impact factors; the *Research Policy*, with 272 frequency and 8,110 impact factors; and the *Strategic Management Journal*, with 231 frequency and 8,641 impact factors. This shows the relevance of these journals to the field. Other journals are also important, although there is a difference regarding frequency. As a whole, they are a relevant group of data sources to the EE, IE and BE research.

Table 2. The most representative journals in the Research Front (journal co-citation network)

Journal	Year	Frequency	Impact Factor
1. Harvard Business Review	2005	314	6.870
2. Research Policy	2007	272	8.110
3. Strategic Management Journal	2009	231	8.641
4. Technovation	2009	173	6.606
5. Academy of Management Review	2007	172	12.638
6. Technological Forecasting and Social Change	2013	167	8.593
7. Entrepreneurship Theory and Practice	2015	137	10.075
8. Academy of Management Journal	2009	121	10.194
9. Small Business Economics	2015	120	8.164
10. Organization Science	2009	117	5.000
11. Journal of Management	2015	106	11.790
12. Journal of Business Research	2014	105	7.550
13. The Journal of Technology Transfer	2013	105	5.783
14. Journal of Business Venturing	2016	104	12.065

Source: Elaborated from the CiteSpace and Journal Citation Reports

It should be noted that the most cited publications from the database, exhibited in Table 1, are not published in any journals listed in Table 2. Table 2 also indicates that the majority of the journals, 12 (twelve), are from Organization and Business fields. Two journals are interdisciplinary: *Research Policy* and *Technological Forecasting and Social Change*.

Continuing the analysis, an important bibliometric investigation is the identification of the most cited publications by area. In this way, Table 3 points to the ten (10) most cited works, which have been published since 2009, and corroborate the understanding of a growing and in-construction field of

study.

Table 3. Most cited papers and areas.

Area	Frequency	Most cited in the database	Reference
Engineering; Business & Economics; Operations Research & Management Science	536	<i>Mode 3' and 'Quadruple Helix': toward a 21st century fractal innovation ecosystem</i>	Carayannis & Campbell (2009)
Business & Economics	269	<i>The lineages of the entrepreneurial ecosystem approach</i>	Acs <i>et al.</i> (2017)
Business & Economics	211	<i>Opening up for competitive advantage—How Deutsche Telekom creates an open innovation ecosystem</i>	Rohrbeck, Hölzle & Gemünden (2009)
Business & Economics; Public Administration	149	<i>Unpacking the innovation ecosystem construct: Evolution, gaps and trends</i>	Gomes <i>et al.</i> (2018)
Business & Economics	148	<i>The digital entrepreneurial ecosystem</i>	Sussan & Acs (2017)
Engineering; Business & Economics; Operations Research & Management Science	139	<i>The technological roadmap of Cisco's business ecosystem</i>	Li (2009)
Business & Economics	118	<i>Clusters, entrepreneurial ecosystem co-creation, and appropriability: a conceptual framework</i>	Pitelis (2012)
Engineering; Operations Research & Management Science	115	<i>Understanding business ecosystem using a 6C framework in Internet-of-Things-based sectors</i>	Rong <i>et al.</i> (2015)
Business & Economics	101	<i>Entrepreneurial ecosystem research: present debates and future directions</i>	Cavallo; Ghezzi & Balocco (2019)
Business & Economics; Public Administration	95	<i>Roles during innovation ecosystem genesis: A literature review</i>	Dedehayir, Mäkinen & Ortt (2018)

Source: elaborated by the author from CiteSpace.

With the intent of examining the existing definitions of EE, IE and BE in the most cited publications of this study, it is indicated that Carayannis and Campbell (2009) understand IE as a system of multilevel, multimodal and multiagent systems. To these authors, the constituent systems are formed of innovation meta-networks and knowledge meta-clusters as construction blocks. Then they are organized in a knowledge architecture and self-referential or fractal chaotic innovation, which constitute an agglomeration of stock and human, social, intellectual and financial capital flow, as well as artifacts, cultural and technological modalities, co-evolving, co-specializing and co-opting continually. The authors suggest a connection between the system theory and the knowledge comprehension, emphasizing multileveled systems in knowledge and innovation.

To Acs *et al.* (2017) the EE approach has two dominant lines: the strategy literature, and the regional development literature. Both lines share common roots in the ecology systems, focusing on the actors' interdependency in a certain community to create new value, developing a new approach to the industrial organization in the last decades. Rohrbeck, Hölzle and Gemünden (2009) suggest that when working cooperatively and competitively with other companies to co-evolve capacities, support new products, satisfy the client's needs and incorporate a new round of innovation, the company builds a BE (Moore, 1993). To these authors, this BE is, therefore, more specifically called an open innovation ecosystem. The authors have analyzed to what extent the open innovation paradigm has been used inside multinational companies.

To Gomes *et al.* (2018), many scholars have proposed and developed the IE concept, which is based on the old concept of BE, initially proposed by Moore (1993). To these authors, the BE is mainly related to capturing value, while the IE is mostly related to creating value. Sussan and Acs (2017) assume that

the EE is also a new form to contextualize social systems, which are more and more complex and interdependent than the ones being created. Li's paper (2009) presents that the BE provides a new perspective to reposition a company's strategies to aggressively promote its agenda and the general health of its ecosystem. Pitelis (2012) does not define EE, the author has studied the transaction costs, the resource knowledge capacities, and the theories based on power control, to provide a comparative perspective based on static governance over clusters. He incorporates it into a more general co-evolutionary organizational theory of the markets, ecosystems and clusters, studying them emerging, their evolution and coevolution. Suggesting that the clusters may involve advantages that help to generate a superior appropriation of the co-created value, in comparison to the alternatives.

In general terms, Rong *et al.* (2015) understand the BE as a business community weakly connected, composed of different levels of organization that share a common aim and co-evolve with each other. To the authors, this concept may provide the companies a wider view of the collaboration between sectors, instead of only the collaboration with partners directly connected in the supply chain. Cavallo, Ghezzi and Balocco (2019) understand that BE condenses from the original swirl of capital, client interest and talents generated by innovation, as well as well-succeeded species bloom from the natural resources of sunlight, water and soil nutrients (Moore 1993, p. 76). In other words, a BE is a network of organizations interconnected that probably operate around a focal company or platform. This analogy with biological ecosystems refers, in essence, to the complexity of relations and interdependency, which is also a Business Ecosystem characteristic, both for its nature and for the way the interested actors interact.

Dedehayir *et al.* (2018) highlight and conceptualize IE as heterogenic constellation of organizations, which co-evolve capacities in the co-creation of values. Producers, suppliers, distributors, financial and research institutions, complementary technology manufacturers, and regulatory authorities, are only some of the organizations that constitute IE.

Intellectual basis of the research field

The author's co-citation analysis relate to the authors referenced by the publications from the search. A co-citation occurs when there is a citation from two authors at the same time. The most co-cited authors may be considered important, since they are cited by a great number of researchers, therefore, they compose a mainstream of research related to EE, IE and BE. In Picture 5, it is possible to see the most co-cited authors. The size of the knot is related to the frequency of co-citation, the bigger the frequency, the bigger the knot (Garcia *et al.*, 2021).

Picture 5: Network of authors cited in the 622 papers.



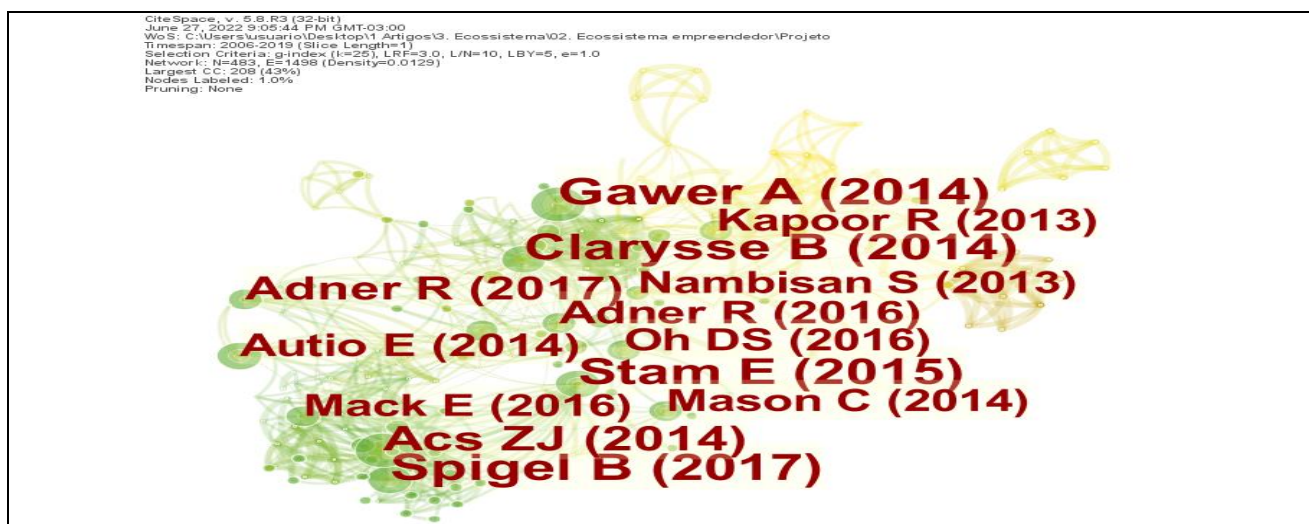
Source: Elaborated from CiteSpace.

When most of the inside analysis of the base papers was done, the study raised the most cited authors

in the network comprising the 622 papers. The most cited author from the analyzed base, with a frequency of 150 times and a high level of centrality, Moore (2008) appears at the top of the ranking, ordered according to criteria determined by citation count and influence on the field. Over 10 (ten) years after the publication. The second most cited is Adner (2008), holding a 102-time frequency and a high level of centrality, and, lastly, Iansiti (2006), in the third collocation, with a 98-time frequency and high level of centrality.

To continue, in Picture 6 is presented the WOS database search co-citation network, in other words, the references done by the research. The papers' co-citation, in comparison to the authors' co-citation, reveals cited papers in two or more researches. The greater the number of co-citations, the more relevant the publication is to the field. Each knot is a paper and shows the author first and the publication year next.

Picture 6. Co-citation network.



Source: Elaborated from CiteSpace.

As it is observable, the most cited papers were published, at least, 9 years ago, it is recent, but it differs from more mature fields. These more mature fields of knowledge have their most central papers published last century (Garcia *et al.*, 2021). Analyzing the papers presented in Picture 6, it was noticed that they are not between the papers referenced in Table 1. Therefore, it is suggested that in the EE, IE and BE fields of research, the research front — which refers to the most cited papers from the database — does not reflect on the intellectual base. This fact indicates a relation to the original area of the field, which comprehends strategy and regional development. The papers shown in Picture 6 approach EE, IE and BE both in a business strategy level and a regional development level, in a wider analysis. Spigel (2017) examines the attributes that constitute the business ecosystems, the relations between them, and how they influence the competitiveness of new undertakings. The analysis of these attributes helps to differ the results of a successful ecosystem – high rates of entrepreneurship, from the inside process, and governance strategies that create and support it.

Gawer and Cusumano (2014) sought to clarify the relationship between IE and the industrial platforms, presenting how these platforms are connected with the innovation management inside and outside the company. These authors present two predominant types of platforms: intern or specific platforms — comprehending the set of assets organized in a common structure from which a company may develop and produce efficiently a flow of derived products; and the external or sector platforms — comprehending products, services, or technologies that act as a base on which outside innovators, organized as an innovative business ecosystem, may develop its products, technologies, or

complementary services.

Stam (2015) presents a summary, which includes a casual scheme of how the structure and systemic conditions of an ecosystem lead to specific entrepreneurial activities, which may create new value as an ecosystem result, or cause it to leave the ecosystem, generating consequences to regional policies. On the other hand, Claryssea *et al.* (2014) analyzed the knowledge and business ecosystem, and the financial support network. The authors focused on understanding whether the knowledge ecosystem is translated into a business ecosystem, suggesting indications of innovative policies aimed to foment the business ecosystem. Lastly, Adner and Kapoor (2016) present a structure to analyze the pace of technology replacement, considering the differential impact on the ecosystem of new and old technologies.

It is observed, consequently, that the most cited publications by the database papers are related to EE, IE and BE under the perspective of strategic and regional development. This fact points to opportunities for new research that maps and deepens the field's understanding of the distinction of concepts within the field.

Research agenda

Considering the creation of a future research agenda, the study reviewed the research indications present in the fifteen most cited papers published in 2021 and within January and March of 2022 — since they are recent and considered by the academic community. The insights obtained throughout the development of this research were also considered. This resulted in three (3) suggested topics for future research, divided in EE, IE and BE.

Although there are publications aiming to research BE in the database, the fifteen most cited works do not aim to study this subject specifically, and, therefore, do not appear herein in the research agenda. After mentioning that, the agenda and suggestions for future research relate according to Frame 3.

Frame 3. Agenda and suggestions to future research

Entrepreneurial Ecosystem	Innovative Ecosystem
Entrepreneurism Wurth; Stam & Spigel (2021); Donaldson (2021); Wei (2022); Harima; Harima & Freiling (2021); Roundy (2021); Abootorabi <i>et al.</i> (2021)	Innovation Madanaguli <i>et al.</i> (2021)
Regional Development Cao & Zhang (2021); Yang & Zhang (2021)	Sustainable growth Oliveira-Duarte <i>et al.</i> (2021)
Well-being Penco; Ivaldi & Ciacchi (2021)	Human Capital Kotsopoulos; Karagianaki & Baloutsos (2021)
Sustainable Innovation Khatami <i>et al.</i> (2021)	Bibliometric Foguesatto <i>et al.</i> (2021); Gu <i>et al.</i> (2021)

Source: Elaborated from the most central papers in the Research Front.

The first one relates to EE, which is an abstract idea of a real-world phenomenon. EE is a systemic approach, that defends the entrepreneurial activity as an entrepreneurial behavior inserted in certain contexts (Acs *et al.*, 2011), instead of treating the entrepreneurial activity as isolated from the others. This approach combines the regional development and strategic management literature (Acs *et al.*, 2017) and relates it to entrepreneurship and economic growth (Acs *et al.*, 2018; Cao & Zhang, 2021). The studies suggest research around the relation with: entrepreneurship; regional and sustainable development; well-being and sustainable innovation. In general, the papers suggest exploring a better holistic comprehension of the EEs, how they are associated with the other concepts and with the empirical reality of the ecosystems. Although the concept itself is subject to growing scrutiny and has been explored from a variety of perspectives, more works focused on the interaction between EE and

the other topics in Frame 3 are necessary.

The second is related to IE, which are dynamic deliberate networks with complex connections built based on reliability, value and technology co-creation, or mental skills. The construction of IE offers a new view over modeling the collective dimension of value creation. The studies identified in the research agenda suggest publications with links to: innovation; sustainable growth and human capital. In general, the papers suggest future research to describe methods of measuring the performance of IE considering sustainable growth, the UN's sustainable growth aims, innovation and human capital. Including research that evaluates the value distributions proposed by Adner (2017). Moreover, other research on IE may focus on the development of ecosystem platforms, enabling to model and capture IE self-organization and self-development mechanisms, according to the approach proposed by Tolstikh *et al.* (2020).

In addition to the research indications already evidenced, the relevance of research that seeks to analyze the role of public administration for the EE, IE and BE is suggested, considering that no indexed paper about this economic actor was found.

Final considerations

The objective of the present study was to analyze how the field of studies on EE, EI and EN is configured, to establish theoretical relationships, and, from that, to develop a prospective agenda for future investigations. To achieve this objective, we undertook a thorough analysis of the international literature concerning EE, EI and EN, with a special focus on identifying authors, countries, references and keywords, among other elements, and on the elaboration of a research agenda for future studies. This analysis encompassed the application of a bibliometric review, employing quantitative approaches to scrutinize academic production in an established field of study.

The results and discussions carried out in this study made it possible to understand the horizon of what has been researched on EE, EI and EN in the world, allowing us to suggest a guideline of articles, authors and journals that are central to the field of research. Furthermore, by presenting the keywords with the highest co-occurrences and the growth of keywords over time, this work allows the identification of more recent and central issues that are related to EE, EI and EN, collaborating with the understanding of what has been researched in the scientific community around the world. In the end, when we present a plausible research agenda, based on the most recent and cited international articles, this article displays gaps and opportunities for new points of study. Based on the main results, we can extract several suggestions that help us understand the dynamics of this field of research.

To begin, we observe that research on EE, EI and EN had an interesting trajectory over the years, with origins in the 1990s, but gaining a broad increase since 2014. We suggest that this increase in research activity reflects the growing interest in issues related to entrepreneurship, innovation and business ecosystems. This is probably driven, among other elements, by significant changes in the global economy and technology, as pointed out by Adner and Kapoor (2016). The analysis of the frequency of publications by country revealed a discrepancy, regarding the relationship between developed and underdeveloped countries, with a notable concentration in developed countries. This suggests the need for more equitable representation of diverse economic and social contexts in future research, as different cultural and economic contexts can influence research and practice in EE, EI and EN.

The co-occurrences of keywords revealed the interconnection between actors, technology and institutions in the fields of EE, EI and EN. These interconnections are fundamental to understanding how companies and business ecosystems operate, as well as how institutions and technology play a crucial role in promoting regional development and economic growth. The analysis of the categories available on the Web of Science database highlighted the predominance of the category "Business and

Economy”, emphasizing its relevance. However, the absence of articles in the Public Administration category highlights the need to include a Public Administration perspective. Public Administration and the areas of EE, EI and EN include multiple institutional logics and social objectives, that justify the importance of an integrated approach.

The analysis of the main articles in this research field revealed that the studies generally focused on contexts that are external to organizations, present in a certain region, that capture or create value, and that contribute to competitive advantages at the company level. This reflects the search for new opportunities and the development of regions, both at the micro and macro levels. When exploring the most representative journals, we identified that many of them are specific to the area of Organization and Business, with some of them being interdisciplinary. This highlights the interconnection of these areas with other disciplines.

When examining the intellectual basis of the research field, we observed that among the network of authors cited, three were the most prominent: Moore (2008); Adner (2008) and Iansiti (2006). About the co-citation network, they indicate a connection with the original area of the field, which comprises strategic and regional development. This suggests that we can't understand the topics of EE, EI and EN in isolation, and that they are intrinsically related to business strategies and regional development.

Finally, we suggest an agenda for future research based on literature reviews. We also indicate the necessity of systematic reviews focused on a national level, to examine Brazilian research on EE, EI and EN, since the country, despite appearing on the international base, has little representation. Furthermore, it is important to analyze the research agenda of the most recent works at the national level, in conjunction with what was presented in this article, to verify how the fields of EE, EI and EN should move forward in the coming years, both in Brazil and around the world.

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