Interactions Between University-Company-Government and the Entrepreneurial Ecosystems: Systematic Literature Review

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Abstract

This research aimed to analyze how scientific and technological publications have characterized, in the last ten years, the interaction between university, business, government and entrepreneurial ecosystems for innovation. Therefore, a research was carried out whose objective was bibliographical in nature, with a qualitative, descriptive approach, covering the period from 2011 to the first quarter of 2021, using, for this purpose, the databases ScienceDirect and Scopus. Then, the results found were analyzed using the My-SAE and VOSViewer software. The results showed that there is a predominance of studies on university entrepreneurship and how the dissemination of knowledge learned in universities contributes to the sustainable development of entrepreneurial ecosystems through the emergence of new entrepreneurial agents. As research results, the entrepreneurial ecosystem with a complex adaptive system, the predominance of studies on university entrepreneurship, innovation, regional economy and sustainable development was presented.

Keywords: *entrepreneurial ecosystem, entrepreneurship, innovation models.*

1. Introduction

Globalization has brought with it the increased importance of local development, which in turn involves social, cultural and political factors that are not exclusively regulated by the market system (Cicconi, 2013). The social and economic development of a region, in turn, depends heavily on its ability

to generate and convert knowledge into innovation through the action of institutional agents. Among these, Etzkowitz and Leydesdorff (2000) appoint universities, companies and the government that are part of the National System of Science, Technology and Innovation (SNCT&I) as protagonists, due to the role that each of these agents have, as well as in resulting from the enhancement of results due to their interactions.

From this perspective, so that the aforementioned interactions can result in innovations for society, Etzkowitz and Leydesdorff (2000) proposed the Triple Helix model. This model establishes an interactive relationship between universities, companies and government, so that each link has a responsibility: the university is responsible for developing knowledge while companies are responsible for the practical application (production of goods and services) and the government for developing public policies to finance and reduce the difficulties encountered during the development of a culture of innovation.

However, with the growing importance of the Triple Helix model, other studies have emerged, adding value to this approach, whose purpose is to discuss new methods for knowledge creation. In this tuning field, Lombardi et al. (2012) proposed the Quadruple Helix model, which adds civil society to the process of interactions, as well as media and cultural perspectives in university-business-government relations. In this approach, knowledge and innovation policies and strategies must recognize society's role in achieving goals and objectives. Furthermore, according to Mineiro et al. (2019) society, in addition to bringing culture and values with it, is a user of innovation, which in a certain way ends up driving innovation processes and assuming a central role.

Further on, the environmental issue gained prominence in the discussion of the innovation process, since society started to demand sustainable solutions, bringing the Quintuple Helix model as a sustainable balance between the paths of development and economy for the continuation of society's progress in itself (MINEIRO et al., 2019).

According to Cicconi (2013), sustainable local development generates social, cultural and environmental benefits, in addition to economic benefits, and started to be analyzed from the perspective of innovation, which has created a close relationship with entrepreneurship, which has gained strength in recent years.

Thus, innovation has become an important tool for the entrepreneur, since it allows the means by which it is possible to explore changes as a business opportunity or a different service. This tightening takes place in a complex and dynamic environment, which evolves as the agents involved tend to reinforce this interaction, similar to what occurs in an entrepreneurial ecosystem formed by several agents that act independently, but that somehow establish relationships between them.

At this juncture, neverthless, the need to understand what an entrepreneurial ecosystem is, becomes evident. The entrepreneurial ecosystem is formed by the web of relationships between all agents that contribute directly and indirectly to the development of organizations (SEBRAE, 2016). These agents belong to the university-enterprise-government triad, such as professionals from the public or private sector, academic scholars, or even entrepreneurs who have a high degree of experience or knowledge about certain conditions that affect entrepreneurship. Such actors, according to the report developed by the Global Entrepreneurship Monitor - GEM (GEM, 2019) can be understood as specialists capable of promoting a contextual view of the environment in which businesses are developed in a country, to the point of recommending implementation of vital improvements to activities entrepreneurs in a nation such as

financing for new businesses, government policies and programs to support entrepreneurship, education and training, technological development and infrastructure, among many other aspects related to the theme.

In the case of Brazil, according to GEM (2019), 67 professional specialists from different areas of specialization associated with the phenomenon of entrepreneurship were interviewed with the purpose of providing an authoritative overview of the environment for entrepreneurship in the country. The result showed that 60% developed recommendations that relate to the factors "government policies" and "education and training" such as: reform of the national tax system in order to simplify and reduce taxation; extensively review current legislation to minimize levels of legal uncertainty in the business environment in Brazil; establish a pact between federative entities and society around public policies that are known to be positive to ensure the stability of operational and financial support programs for entrepreneurship; to institute entrepreneurial training as a State policy; include notions of financial education in elementary and high school; to conceive entrepreneurial education as an instrument of social ascension and personal development, avoiding being a resource destined only to the wealthier social classes.

Given the above, this research seeks to answer the following question: **How have scientific and technological publications characterized, in the last ten years, the interaction between university, business, government and entrepreneurial ecosystems for innovation?**

From this, the objective of the research is to analyze how scientific and technological publications have characterized, in the last ten years, the interaction between university, business, government and entrepreneurial ecosystems for innovation. Specifically, the research will present the main networks of citations and co-citations among authors of the themes and countries, demonstrate the most relevant works for the formation of concepts about the entrepreneurial ecosystem and its interactions, as well as the main research axes on the theme through the keywords used by the authors.

This investigation, therefore, is justified in the sense of building a conceptual base on the researched topic in order to understand how the interactions between the agents of an entrepreneurial ecosystem take place. Furthermore, it is noteworthy that the central theme presents a dynamic in scientific publications as a result of the development or emergence of entrepreneurial ecosystems, which encompasses a conceptual variety of different perspectives on entrepreneurship. The construction of a conceptual base on the researched topic will allow the academic community that develop researches to seek and spread knowledge through scientific partnerships whose objective is to advance in local development research based on entrepreneurial ecosystems.

In addition to this introduction, the research is structured in four other sections: in the second section there is a systematic survey of the literature on the interactions between university-company-government and entrepreneurial ecosystems. The detailed methodology is found in the third section. The fourth section presents the results from the exploratory analysis, as a way to present the state of the art about ecosystems and their interactions. Finally, the fifth section presents the final considerations and limitations of the research.

2. Literature Review

In this section, at first, the definition of ecosystem will be discussed, an intrinsic concept to understand how the relationships between the agents involved in an Entrepreneurship Ecosystem happen and how it works. Then, the Triple Helix, Quadruple Helix and Quintuple Helix models will be presented, and finally, a review of the last ten years on the relationship between university-business-government and entrepreneurial ecosystems, object of study of this research.

2.1 Entrepreneurial Ecosystems and their functioning

The concept of ecosystem comes from the Ecology of the term "ecological system", which according to Acs et al. (2017) can be understood as a biotic community, its physical environment and all possible interactions between living beings and non-living components.

By bringing the concept to a productive environment, in which the entrepreneurial activity depends on a set of interconnections between agents that form a dynamic system, Isenberg (2011) defines the entrepreneurial ecosystem as a result of the interaction between its agents that compose it, which they evolve together and strengthen together. In this sense, some definitions for the expression entrepreneurial ecosystem can be observed, as shown in Table 1 below.

Table 1

Definitions of the entrepreneurial ecosystem

Author	Definition
Isenberg (2011)	The entrepreneurial ecosystem concerns the context in which the enterprise is inserted, taking into account politics, economy, culture, support, human capital and access to Marketplace.
Stam (2015)	The entrepreneurial ecosystem comprises a set of interdependent agents and factors that are governed in a way that enables productive entrepreneurship.
Spigel (2017)	An Entrepreneurial Ecosystem is about the combinations of social, political, economic and cultural elements within a region that support the development and growth of innovative startups and encourage new entrepreneurs.
Roundy, Bradshaw e Brockman (2018)	Entrepreneurial Ecosystem is a complex adaptive system influenced by three forces that drive it: entrepreneurs' intentionality, coherence of entrepreneurial activities and injections of resources.

Source: Prepared by the authors from Isenberg (2011); Stam (2015); Spigel (2017); Roundy, Bradshaw and Brockman (2018).

In light of the above, the discussion on entrepreneurial ecosystems and their functioning is presented below.

For the functioning of an entrepreneurial ecosystem, Singer et al (2015) highlight that financing, government policies and programs, entrepreneurship education, among other elements, are essential for the

analysis of an entrepreneurial ecosystem. These elements, in a way, show the relationships of at least three agents in this ecosystem (university-company-government) that contribute to the economic development of a given location, technological innovation and production of new knowledge.

Also with regard to the functioning of an Entrepreneurial Ecosystem, Isenberg (2011) highlights that not only university-company-government influence its development, but also other agents that relate to six dimensions defined by it as pillars of an ecosystem. entrepreneur. Each dimension presented by Isenberg (2011) has its role in the formation of an ecosystem, without a centralizing agent to control it or even a chain of interactions as cause-effect, since the entrepreneur can simultaneously interact with the six dimensions listed in Table 2 below.

Table 2

Dimensions of an entrepreneurial ecosystem

Component	Definition/ characteristic
Public Politics	they feed the ecosystem as they provide ideal preconditions for thriving local entrepreneurship.
Finantial Capital	available and accessible to all sectors of the ecosystem, whether through development agencies, angel investors or the entrepreneur's own risk investment.
Culture	tolerant to generate more learning.
Support Institutions	to integrate ecosystem agents to offer complementary infrastructure services, non-governmental entities and support professions.
Human Resources	human capital trained via entrepreneurial education
Accessible Markets	resources, space and business opportunities.

Source: Isenberg (2011)

By defining these dimensions, Isenberg (2011) allows us to reflect on the complexity and high degree of uncertainty in the formation of an entrepreneurial ecosystem, since each agent involved has an individual system with its own goals, interests and particularities. At the same time, it is worth emphasizing that an agent cannot function well in isolation, as, although one of the dimensions promotes effective actions to encourage local entrepreneurship, synergy in such a dynamic system is only achieved through a relationship. What is the use, for example, of public managers removing barriers to the development of an entrepreneurial ecosystem, if there are no financial resources available for start-up companies, or even a strong culture that provides positive values, attitudes and behaviors for the entrepreneurial activity.

Theodotou et al. (2012) agree with Isenberg (2011) and more explicitly cite key components that give consistency to an entrepreneurial ecosystem such as: customers; startups; angel investors and venture capitalists; TV, radio, social media, publications in newspapers, magazines and blogs; service providers (accountants, lawyers, consultants, insurance companies); universities and research and development institutions; and productive sector (chamber of commerce, business associations, non-governmental organizations, informal business groups, incubators, accelerators, among others).

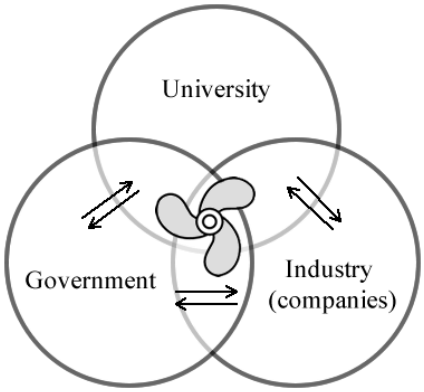
2.2 The University-Company-Government interaction and Entrepreneurial Ecosystems

From the perception that the university-business-government relationship contributes to the development of a locality, theoretical models have emerged over the years with the purpose of reflecting the reality of the innovation processes of a region to improve its production systems through generation, accumulation and application of knowledge. Auxiliar (2010) translates as a network of institutions and agents from the public, academic and private sectors, the State institutions linked to innovation and technological development, the accessibility network, universities, companies, business associations, science and technology parks, thus composing an Innovation System, be it national, regional or local.

Among the theoretical models mentioned, we have the Triple Helix approach presented by Etzkowitz and Leydesdorff (2000), which has an approach based on the perspective of the University as an inducer of relations with the productive sector of goods and services (companies) and the regulatory sector and promoter of economic activity (Government) thus aiming at the production of new knowledge, technological innovation and economic development, as shown in Figure 1 below.

Figure 1

Triple Helix Model



Source: Elaborated by the authors from Etzkowitz and Leydesdorff (2000)

Etzkowitz and Leydesdorff (2000) emphasize the dynamism of the three university-company-government helixes through the structural changes of the institutions involved in a constant process of learning, adjustment and functionality of each sphere. These institutions are mentioned as a helix to show the spiral shape of the interconnections between them, formal and informal, establishing an interactive relational network.

However, Auxiliar (2000) emphasizes that the evolution and success of the relational network established between universities, companies and government are consequences of the region's capacity to determine what it does best, define technological resources to be exploited and have a vision strategic at the governance level.

Carayannis and Campbell (2009) started to defend the importance of society in this interactive relational network between universities, companies and government, recognizing that it ends up in a certain way influencing a community of innovation, either because of the fact that it is a consumer, of reinforcing culture region or even as a driver of innovation processes.

Thus, the Quadruple Helix emerges, adding a fourth helix to the interactive relationship between the conventional approach of universities, business and government. The fourth helix according to Mineiro et al. (2019), would be aimed at the media, culture and civil society, in order to recognize the important role of society in achieving the goals and objectives of policies and strategies for knowledge and innovation, emphasizing that society is built and communicated by the media and influenced by culture and values.

In this perspective, Mineiro et al. (2019) pointed out as the most frequent, the following representations of society: a) Civil Society and Broad Community; b) Public and Civil Society based on media and culture; c) users who are consumers of innovation; d) creative class; e) non-governmental organizations (NGOs) and associations.

Society, in turn, has been demanding sustainable solutions and is concerned with ecological aspects, mainly as a result of the global concern around the environmental issue, which has been enhanced by climate change, which has led to more intense solutions and innovative strategies that consider the environmental, social and governance aspects (Environmental, Social and Corporate Governance – ESG).

Thus, society's natural environments for the production of knowledge and innovation came to be emphasized in the model we call Quintuple Helix contextualizing the approaches defended by the Triple Helix and Quadruple Helix models. According to Yoon, Yang and Park (2017), in the Quintuple Helix model, the environment is considered as the main factor for the survival of humanity and must be included in regional development policies and proposals.

According to Carayannis, Barth and Campbell (2012), Quintuple Helix offers society a model between theory and practice that helps to understand the relationship between knowledge and innovation in order to promote lasting development. Mineiro et al (2019) point out another perspective on the Quintuple Helix model, in which the focus is on transforming scientific-technological knowledge into socioeconomic wealth, based on local vocations, thus contributing to the scientific, technological and innovative development of the region.

In summary, through Table 3, it is possible to observe a summary of the Triple Helix, Quadruple Helix and Quintuple Helix models.

Table 3

Comparison between Triple Helix, Quadruple Helix and Quintuple Helix models

Model	Triple Helix	Quadruple Helix	Quintuple Helix
Author	Etzkowitz e Leydesdorff (2000)	Carayannis e Campbell(2009)	Yoon, Yang e Park (2017)
Agent	Universities, companies, Government.	Universities, companies, Government, Civil Society.	Universities, companies, Government, Civil Society and Environment.

Source: Adapted from Calzada (2017, p. 26)

In the three models, highlighted in table 3, university-business-government agents are central and their interactions must be functional and institutional, and with a broad relationship between organizations to configure themselves as an innovation in constant transition.

Mineiro et al. (2019) list the main roles played by this triad: universities are sources of knowledge and technology with the responsibility to generate new knowledge, seek relationships between government and companies, seek new research gaps and lead change processes; companies that play a production role develop innovative products or services; seek interaction with research centers and lead change processes; the government, in turn, supports new organizational structures to promote economic and social development, builds strategic plans aimed at innovation and knowledge, seeks to foster or finance innovation initiatives and provide benefits to the population through interaction with various political spheres.

Although a set of works are observed in general, Table 4 is presented below with a synthesis of the concepts that will be applied in the discussion of the findings in this research, containing themes relevant to the theoretical framework addressed.

Table 4

Synthesis of the concepts covered in the referential dimension

Temathic	Concept	Authors
Complex System	Entrepreneurial ecosystems can be seen as a complex adaptive system formed by complex components (agents and their non-linear interactions)	Roundy, Bradshaw e Brockman (2018)
Innovation System	An innovation system, national, regional or local, can be seen as a network of institutions and agents from the public, academic and private sectors, whose activities and interactions generate, adopt, matter, modify and disseminate new technologies, and contribute to integrating knowledge into the economy.	Auxiliar (2010)

Source: Prepared by the authors.

The Complex System theme is relevant because when studying the entrepreneurial ecosystem, it is clear that the actions of an agent, for example, contribute in a certain way with possible adaptations or modifications in the ecosystem. With regard to the concept of Innovation System, the relevance for this research is to analyze the relationship between university-company-government.

3. Methodology

3.1 Research Characterization, Materials and Methods

The methodology for this research is based on the application of explicit and systematic search methods, followed by the evaluation of the quality and validity of the studies found, as well as their applicability in the current context of the theme addressed in this research. According to Guanilo, Takahashi and Bertolozzi (2011), systematic review differs from traditional review because it answers a more specific question, which in this case concerns the interaction between entrepreneurial ecosystems and

university-company-government in the last ten years, guided by the presented problem in the introduction, whose answers were formulated from authors and reference studies on the subject.

Therefore, this study was developed primarily using the database ScienceDirect in which a bibliographic survey was carried out in order to verify the evolution of publications on the subject, identify the distribution of these publications, cooperation between authors and institutions and most cited authors. When using words such as entrepreneurship, entrepreneurs and regional entrepreneurship, works with the entrepreneurship theme in general were observed. From this, we chose to use the term "entrepreneurial ecosystem" and its correspondence in the English language "entrepreneurial ecosystem", which constituted the limitations of this research. A time cut was then carried out considering the period from 2011 to 2021. Then, the results were refined to documents such as "articles", "book chapters" and "editorials" thus totaling 217 results, distributed in the areas of business, social sciences, hard sciences, environmental, energy, agricultural and biological sciences, computer science and engineering.

Then, the same search was carried out with the same filter applications in the Scopus database, in which it was possible to obtain around 1,443 results.

The use of the ScienceDirect database is justified because it contains full-text articles from journals and books, mainly published by Elsevier, one of the main "publishers" in the academic field. While the use of the Scopus database allows us to access a comprehensive view of the world's research production in the areas of science, technology, medicine, social sciences, arts and humanities, since it is the largest database of citations and abstracts in peer-reviewed literature, according to Figueiredo et al (2017).

From the searches performed, files with the extension ".ris (Information Systems Research)" were generated, both from the ScienceDirect and Scopus databases, which are mainly used in a quick and easy way to implement citation and bibliography resources in text documents. These files were imported into My-SAE – Semantic Analysis Expert, a software created with the purpose of helping researchers in academic scientific production, aimed at systematic review and semantic analysis, providing data such as the number of citations, JCR impact factor, Qualis-CAPES classification, most published journals, among others, in addition to enabling the creation of networks of the most cited keywords in the database and also in the creation of networks of authors applied to the title or abstract and networks of authors.

By importing the files resulting from the searches into My-SAE, the software eliminated about six (considering the total number of publications found in the two databases) found duplications, thus totaling 1,654 journals related to the keywords "entrepreneurial ecosystem".

Then, Qualis-CAPES and JCR impact factor classification data were imported in order to cross-reference them with the imported database. Once the data was crossed, the year of publication, the Qualis/JCR classification and the most cited results were analyzed, as well as the journals that published the most, incidence of keywords and authors, which will be presented in the next section.

Although My-SAE allows the generation of a semantic network file that can be opened by graph creation and network analysis software, such as Gephi or Pajek, we chose to use VOSViewer due to its ease of handling. it. VOSViewer is a tool to build and visualize bibliometric networks, containing journals, researchers or individual publications, and can be built based on citation relationships, bibliographic coupling, co-citation or co-authorship. In this case, the ".net" extension file generated by My-SAE was not

used to create our bibliometric network in VOSViewer, but the same ".ris" files mentioned earlier in this section.

VOSViewer allows you to create a map with bibliographic data base categorized by: co-authorship analysis, citation analysis, bibliographic connection analysis and co-citation analysis. Thus, the co-authorship categorization was used in order to identify the groups of authors, called clusters by the software, in addition to the co-occurrence of keywords to identify the words with the highest degree of incidence and the connections with the greatest weight for identify those that concern the interactions mentioned in the innovation models mentioned in this research.

One of the limitations found in VOSViewer is that it was not possible to generate a network of most cited authors using ".ris" files, which was irrelevant since My-SAE brought us this information. The visualization of this network would only be possible if only the data from the Scopus database were used, as it allows the generation of a ".csv" file, which would not print the reality of the sample, since there are also data from ScienceDirect in it. Thus, the VOSViewer was used only to generate the co-authorship network and the keyword network, since ".ris" type files are accepted for this categorization.

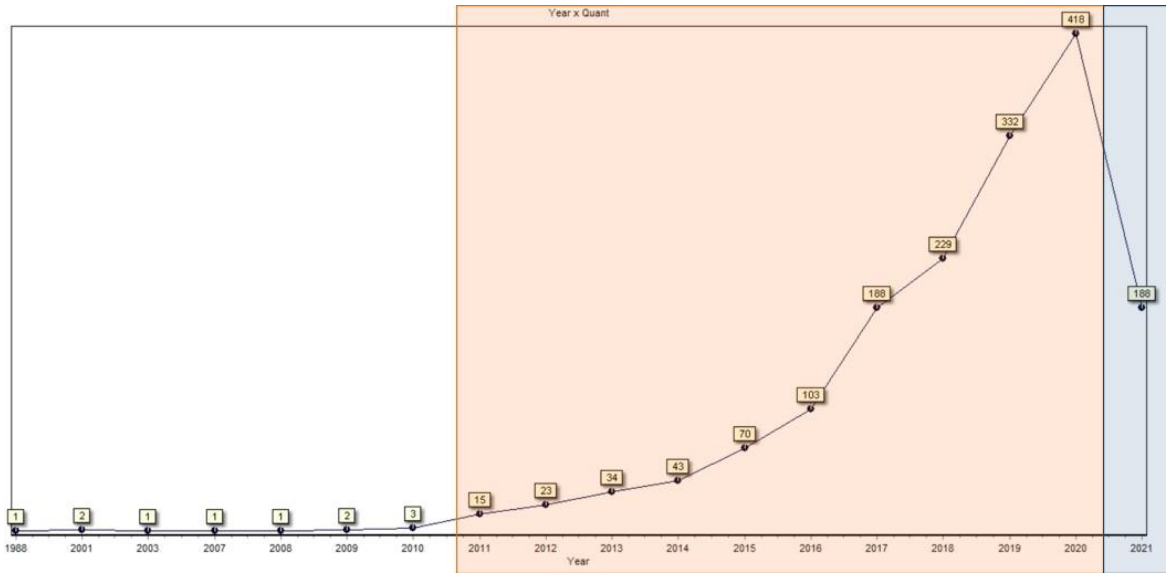
4. Analysis and discussion of results

The results found in the following order will be presented below: (i) number of publications per year in the last ten years; (ii) number of publications by authors; (iii) co-authorship networks; and (iv) main keywords used in the theme.

Through My-SAE it was observed, as shown in Figure 2, a growing number of publications on entrepreneurial ecosystems from 2011 onwards. With regard to the year 2021, only the first quadrimester of the year was considered. Despite this cut, the relevance of inserting the first quarter of the year 2021 was due to the fact that most of the articles published addressed the impact of the formation of an entrepreneurial ecosystem for the development of the economy, according to the authors Wagner, Schaltegger, Hansen and Fichter (2021) who bring in their case study the correlation between universities and sustainable regional and economic development based on the dissemination of knowledge, while promoting the involvement of stakeholders in crucial governance processes at the regional level. Or even the authors Audretsch and Belitski (2021) who point to business activity as an important engine of regional economic growth, given the evidence found in the different economic structures of their study in 267 European regions: those with greater participation of creative industries attract creative entrepreneurship, which grows faster than regions dominated by agriculture and manufacturing sectors.

Figure 2

Chart of publications by year through My-SAE

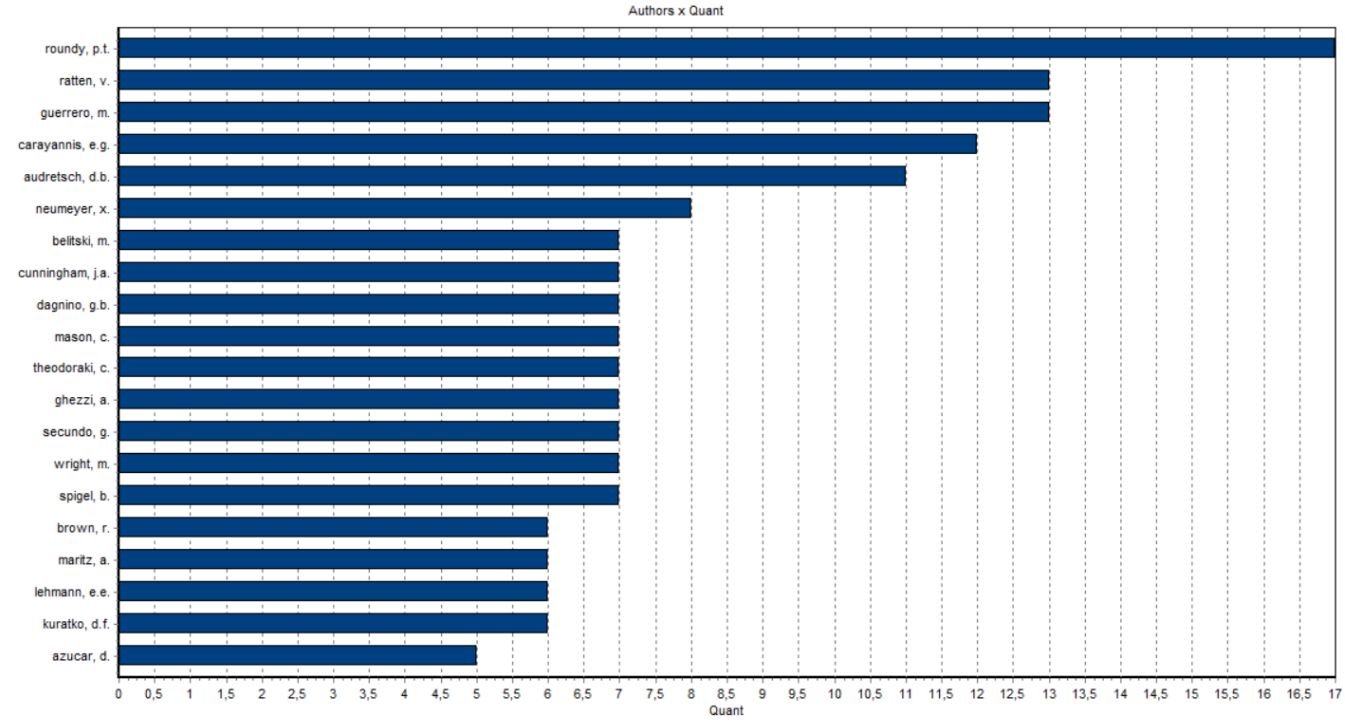


Source: Prepared by the authors.

Figure 3 represents the 20 authors classified by My-SAE with the highest number of publications. The top five with publications above 10 were Round (17), Ratten (13), Guerrero (13), Carayannis (12) and Audretsch (11).

Figure 3

Graph of publications by author through My-SAE



Source: Prepared by the authors.

Also with regard to the authors who published the most according to My-SAE, based on this sampling, we applied a filter to analyze the publications that were most cited, as shown in Table 4.

Table 4 – Articles with the highest number of citations

Author	Article	Year	Citations
Acs, Z.J.; Stam, E.; Audretsch, D.B.; O'Connor, A.	The lineages of the entrepreneurial ecosystem approach	2017	213
Audretsch, D.B.; Belitski, M.	Entrepreneurial ecosystems in cities: establishing the framework conditions	2017	187
Guerrero, M.; Urbano, D.; Fayolle, A.; Klofsten, M.; Mian, S.	Entrepreneurial universities: emerging models in the new social and economic landscape	2016	119
Carayannis, E.G.; Campbell, D.F.J.	Open Innovation Diplomacy and a 21st Century Fractal Research, Education and Innovation (FREIE) Ecosystem: Building on the Quadruple and Quintuple Helix Innovation Concepts and the "Mode 3" Knowledge Production System	2011	112
Roundy, P.T.; Bradshaw, M.; Brockman, B.K.	The emergence of entrepreneurial ecosystems: A complex adaptive systems approach	2018	102

Source: Prepared by the authors.

By analyzing the most cited articles and taking into account the author who published the most, we highlight Roundy's article, published in 2018, whose title is "The emergence of entrepreneurial ecosystems: A complex adaptive systems approach". With about 102 citations, qualis A2 and JCR 2.509 impact factor, the article revealed that the Entrepreneurial Ecosystem as a complex adaptive system that proposes three forces related to the emergence of the entrepreneurial ecosystem: (i) intentionality of entrepreneurs - which concerns entrepreneurs that drive the creation of an entrepreneurial ecosystem from the moment they identify, create and respond to market opportunities; (ii) coherence of entrepreneurial activities - which is related to the acceptance of actions between agents involved in the ecosystem, such as an innovation in a business model being replicated by other entrepreneurs, which the authors call similarity between agents who selected the same innovation; and (iii) injections of resources – which arise in order to encourage ecosystem agents to carry out more entrepreneurial activities with allocation of financial resources in order to allow its development (ROUNDY; BRADSHAW; BROCKMAN, 2018).

Such forces mentioned were found in researches that mention the University-Business-Government triad as a structure that, by having agents involved, mainly with regard to the transfer of knowledge and engaged in their actions, end up creating value for society and regional economy, the example of authors Belitski and Heron (2017) who mention the creation of startups using the knowledge provided in universities.

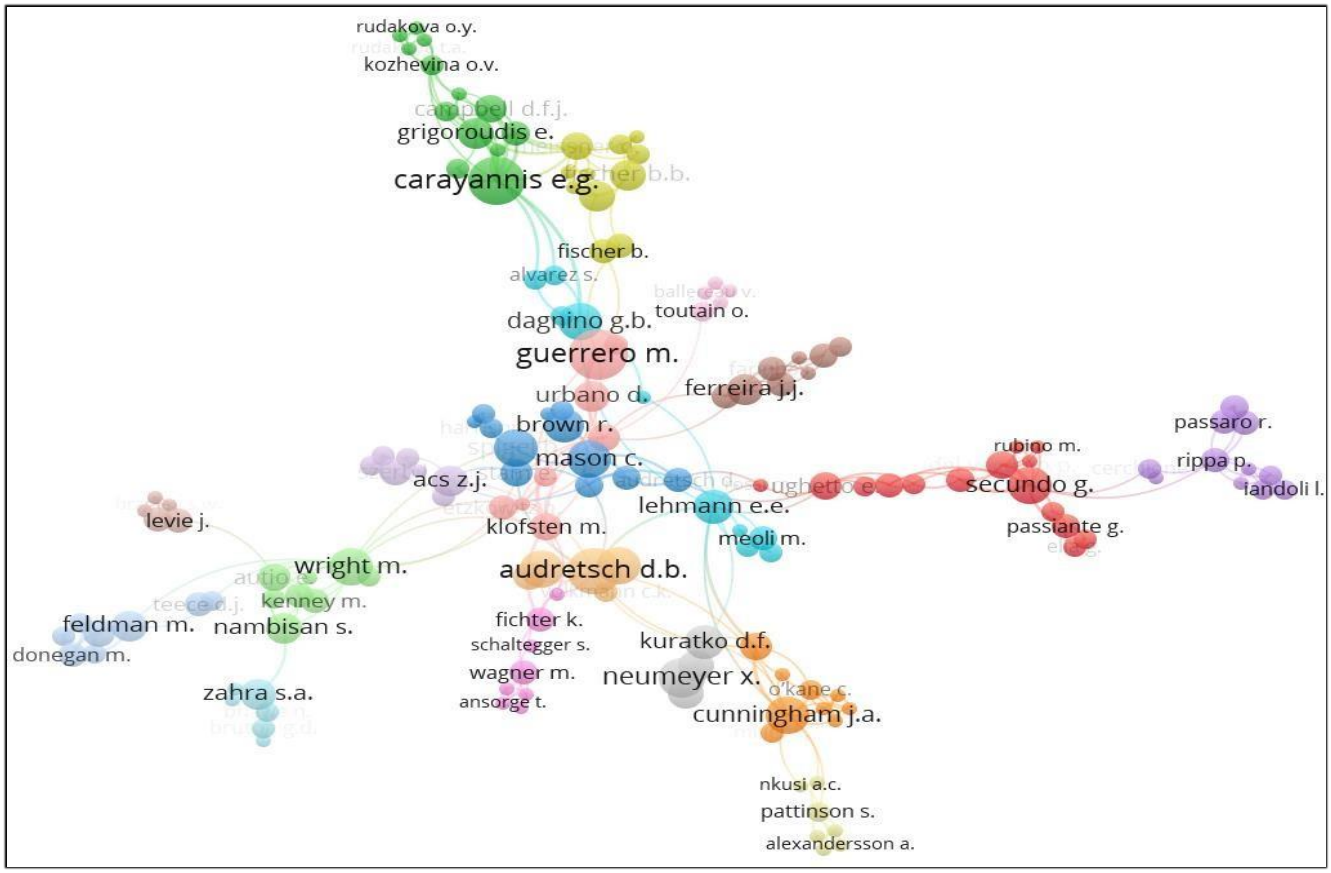
Another important indicator for the analysis concerns the co-authorship network that demonstrates scientific and technological partnerships, providing a standardized view of cooperation between individuals and organizations. Of those listed as the authors who published the most, the co-authorship network (clusters) of the authors Guerrero, Carayannis and Audretsch was verified through the application of

VOSViewer, as shown in Figure 4. For the formation of the co-authorship network, it was established a minimum of 3 documents per author, limiting to 146 authors out of 3568 and a formation of 11 clusters.

It was possible to identify that Guerrero brings in his research the relationship between the performance of entrepreneurial innovations of companies located in emerging economies and the effects produced by the links of companies with other companies, universities and government. In fact, one of Guerrero's most cited articles, the role of entrepreneurial universities stands out as engines of innovation and entrepreneurship activities. It was also analyzed that most of Carayannis' research in his co-authorship cluster addresses discussions about innovation models, policy formulation and governance approach in the context of innovation models, and the interactions between their agents in business ecosystems, while Audretsch in his research with other authors, he addresses issues related to technology transfer, and the relationship between entrepreneurship and regional economic development.

Figure 4

Co-authoring network through VOSViewer

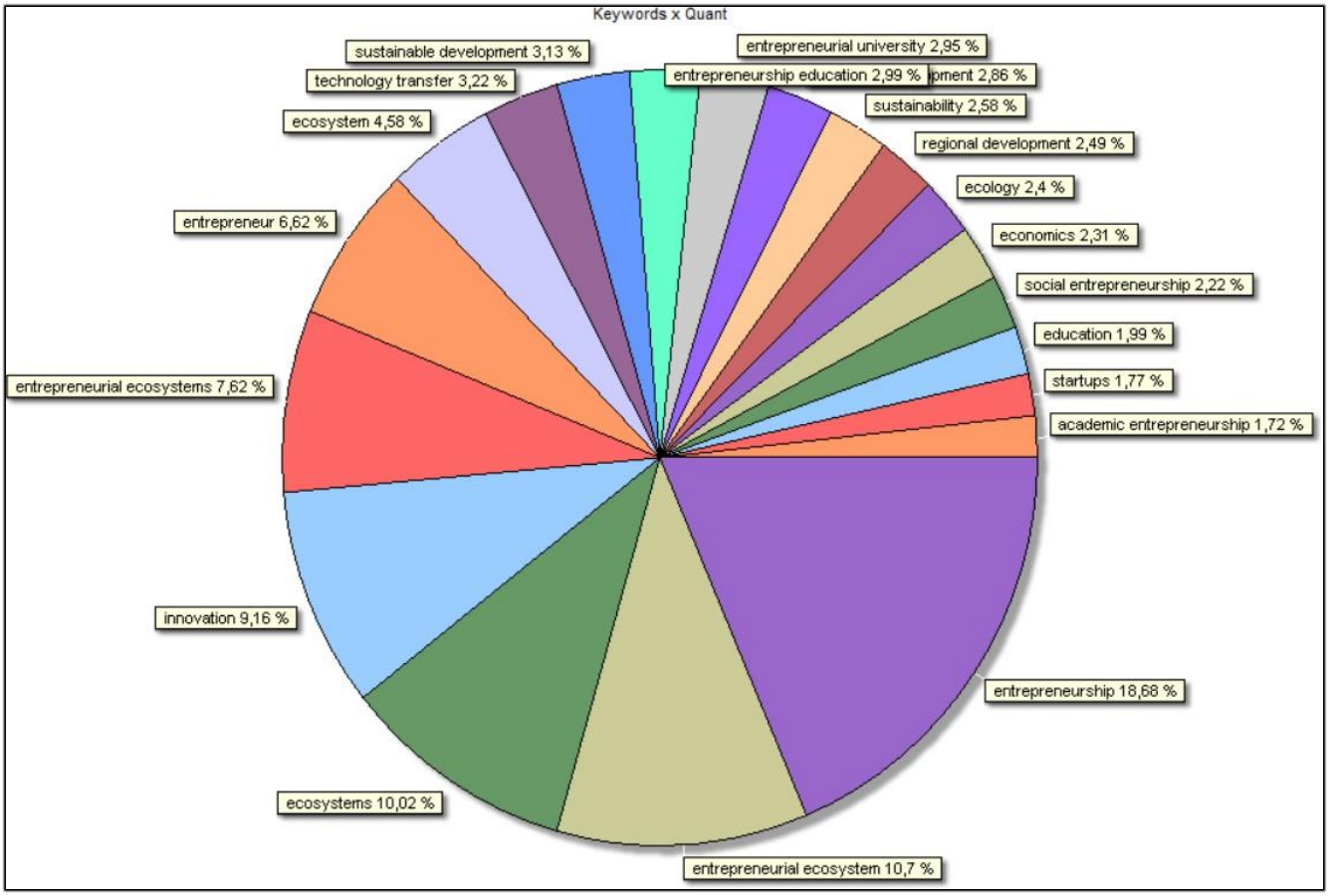


Source: Prepared by the authors.

In Figure 5, the graph with the most used keywords in the researched theme is shown, with the word entrepreneurship with 18.68% among the 20 most representative words, present in 412 articles. It was also observed that there are two slices of the graph dealing with the same occurrence: “entrepreneurial ecosystems” with 7.62% and “entrepreneurial ecosystem” with 10.7%, which are present in 404 articles.

Figure 5

Keyword Graph through My-SAE

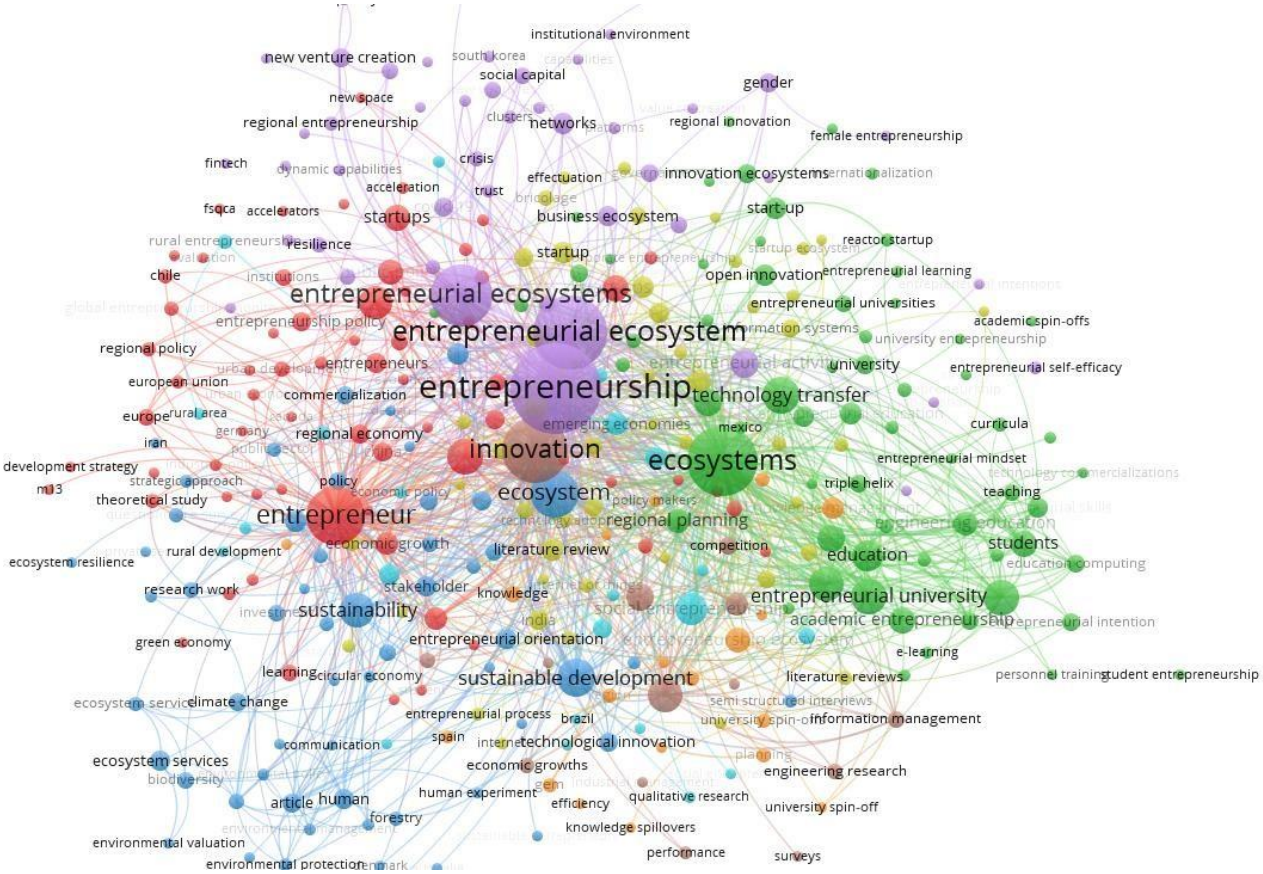


Source: Prepared by the authors.

In order to verify the relationship between the keywords found in the database, we used VOSViewer. Figure 6 represents the co-occurrence network between keywords used by database authors. However, of the 5450 different keywords found, for the formation of the network represented in this figure, there is a minimum of 5 occurrences per keyword in the database articles, limiting to 343 words and a formation of 8 clusters. It is possible to see that the formed network not only confirms the representativeness of the keywords in Figure 6, but also allowed to verify some interesting connections, such as the topics studied in the theme of entrepreneurial ecosystems such as university entrepreneurship, innovation, regional economy, technology transfer, sustainable development, startups, business ecosystem among others.

Figure 6

Keyword network through VOSViewer



Source: Prepared by the authors.

5. Final Considerations

The objective of this research was to analyze how scientific and technological publications have characterized, in the last ten years, the interaction between university, business, government and entrepreneurial ecosystems for innovation. Therefore, a bibliographic research was carried out, with a qualitative, descriptive approach, based on a systematic literature review in the ScienceDirect and Scopus databases. Through the use of My-SAE and VOSViewer software, the number of publications by authors, most cited authors, co-authorship networks, main axes of research on the subject through the keywords used was demonstrated. In this way, the research achieves the proposed objective and brings theoretical contribution when presenting to the academic community that studies the theme where to seek information and scientific partnerships for further research.

The research by Roundy, Bradshaw and Brockan (2018) stands out as relevant in this study, as it evidenced the entrepreneurial ecosystem as a complex adaptive system that is modeled based on the involvement of its agents. The predominance of studies on university entrepreneurship, innovation, regional economy and sustainable development is also highlighted, both by the occurrence of keywords that relate to the central theme of this research as well as by the main authors mentioned.

It was evident that in the researches that indicate university-company-government as agents that contribute to the formation of an entrepreneurial ecosystem, they drive regional economic development.

Thus, it is concluded that although there is no centralized control in an entrepreneurial ecosystem, university-company-government agents, present in the innovation models discussed in this research, enable innovations in constant transition by maintaining their functional interactions and with a broad relationship between the organizations that surround this triad.

There was also the identification of a considerable growth in the number of publications on entrepreneurial ecosystem from 2016 onwards, especially with regard to the link between the formation of an entrepreneurial ecosystem and sustainable regional and economic development through the dissemination of knowledge generated in universities.

As a limitation, the use only of the ScienceDirect and Scopus databases is highlighted, thus suggesting future studies in other research bases and the performance of other analyzes allowed by the My-SAE and Scopus software. It is also recommended as works a more in-depth study in relation to the determining factors for the development of an entrepreneurial ecosystem, as well as a possible mapping of interactions that weaken it.

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