

Entrepreneurial Ecosystems: A Technological Perspective View

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Abstract

Entrepreneurial ecosystems have raised a great debate about the dynamics in which companies relate and seek common economic development. To better understand this type of phenomenon, we sought to analyze entrepreneurial ecosystems from the perspective of technology. For this, a systematic review of the literature was used with the technique of content analysis in 43 publications on the subject. As a main contribution, the study presents four main categories that relate technology to entrepreneurial ecosystems: (i) Configurations and Structures; (ii) Role of universities; (iii) Digital Transformation and (iv) Internationalization and Diversity. The research highlighted that there are still important challenges to be tackled in the subject with a mapping of the main theoretical gaps found.

Keywords: Technology; Entrepreneurial Ecosystems; Systematic Review; Future Perspective

Introduction

In recent years, we have seen technology play an essential role in the way society relates to new products and services, driving economic and social progress. Entrepreneurship then appears as an activity that welcomes these new technologies and uses them in the best way for the development of organizations (Garud and Karnøe, 2003; Nambisan, 2017).

In this sense, several dynamic entrepreneurial initiatives with models of Startups have drawn the attention of researchers about their cooperative performance. They are called entrepreneurial ecosystems, work systems in which several actors relate and have an interest in favor of general development (Ratten, 2020). In general, they occur in environments that promote the creation and growth of innovative companies, where entrepreneurs, investors, governments, etc. collaborate to foster the development of new ideas and solutions (Zahra and Nambisan, 2011; Stam, 2015; Subrahmanya, 2017; Spigel and Harrison, 2018).

Research about the use of technology in entrepreneurial ecosystems is still at an early stage in the state of the art (Alvedalen and Boschma, 2017). Studies are still presented in an initial exploratory way to understand how technology can be used to boost the creation of companies and promote innovation (Attour and Lazaric, 2020; Muldoon et al. 2022).

It is understood that investigating the interaction between technology and entrepreneurial ecosystems allows exploring the challenges and opportunities that arise in these dynamic and complex environments, especially due to the number of actors and variables present in each reality of organizations (Cao and Shi, 2021).

Audretsch et al. (2019) reinforce the importance of researching technology in entrepreneurial ecosystems, especially on the potential impact it can have on the economy. Technology-based startups have demonstrated rapid growth and the ability to create high-quality jobs. The quest to understand how emerging technologies, such as artificial intelligence, blockchain, Internet of Things and augmented reality, can be applied in this context can help boost entrepreneurship and innovation (Bouncken and Kraus, 2022). This is justified by the highly dynamic and complex environment in which these entrepreneurs operate and need to adapt quickly to remain relevant.

Therefore, this article seeks to present a framework with the main theoretical and empirical contributions on technology in entrepreneurial ecosystems and their future paths. That is, with a focus on identifying theoretical contributions, it goes beyond the analyzes carried

out by Bejjani; Göcke and Menter (2023), Cao and Shi (2021) and Maroufkhani; Wagner and Wan Ismail (2018).

Initially, we address the importance of technology in entrepreneurship, then we present the issue of technology in entrepreneurial ecosystems, and the method used in the study. And finally, we present the contributions and final considerations on the subject.

Contextualization of Technology in Entrepreneurial Ecosystems

Technology and innovation are considered essential elements for the success of entrepreneurship. Undoubtedly, technology has transformed the way companies work and are evaluated (Bailetti, 2012). However, it is still important to understand the dynamics and complexity of the present challenges, especially regarding the advancement of digitization in the entrepreneurial context (Giones and Brem, 2017).

It is undeniable that technology presents itself as a powerful tool to enable the creation and management of businesses on a global scale. It facilitates access to information, and especially after the pandemic, it allows for remote collaboration, which is critical to the successful interaction of many organizations. Furthermore, technology can help reduce costs and increase operational efficiency, allowing entrepreneurs to focus on developing their business ideas (Jafari-Sadeghi et al. 2021; Mosey; Guerrero and Greenman, 2017; Lafuente et al. 2020).

In the context of the entrepreneur, the use of technology can bring significant benefits, but it also presents challenges and risks that must be considered. Technology can create an over-reliance, many companies believe that adopting advanced technologies and innovative solutions is the key to achieving success. However, this belief can lead to errors in other aspects, considering the lack of business strategies, revenue models and management skills (Muegge, 2013).

This difficulty is also directly found in entrepreneurial ecosystems, especially in relation to collaboration and competition. Technology can facilitate or hinder collaboration between entrepreneurs, an important dilemma to consider as entrepreneurs seek to stand out in an increasingly competitive global market (Roja and Nastase, 2014).

In this sense, it appears that although technology can boost the growth of entrepreneurial ecosystems, it can also accentuate existing disparities in the relationships between the various actors. Entrepreneurs with financial resources and access to technical knowledge are more likely to adopt and use cutting-edge technologies (Cooper and Folta, 2017), while entrepreneurs from marginalized locations (countries) or with limited resources may be at a disadvantage (Cao and Shi, 2021; Siqueira and Bruton, 2010).

Scaringella and Radziwon (2018) present the relationship between innovation, entrepreneurship and business ecosystems. The authors examine the literature and current practices related to these topics, highlighting similarities and differences between them. They discuss how business ecosystems can facilitate the creation, sharing and transfer of technological knowledge among the actors involved, promoting the generation of new ideas and opportunities.

Still thinking about relationship and technology transfer, Rodríguez-Aceves, Mojarro-Durán and Muñiz-Ávila (2019) examine evidence related to technology transfer policies and infrastructure. The authors investigate how these policies can facilitate the transfer of knowledge and technology from the academic environment to the business sector, promoting the creation of startups and the development of partnerships between universities and companies. Here, a relevant point is the contribution on the need for adequate resources, such as laboratories, new incubators, which can provide support and technological resources for entrepreneurs in ecosystems.

Recently Zahra and Hashai (2022) studied the effect of acquisitions of technology startups by entrepreneurial multinationals on the entrepreneurial ecosystems of small open economies. The authors explore how the entry of multinationals can affect competition, access to resources, collaboration between actors and the development of local startups. They also discuss the challenges and opportunities these technology acquisitions can bring to local businesses and the wider ecosystem. In short, despite recent efforts to understand the role of technology within these ecosystems, it appears that the literature is still decentralized, and there is no concrete systematization about the theoretical gaps and the main contributions on the subject (Maroufkhani, Wagner and Wan Ismail, 2018; Bejjani, Göcke and Menter, 2023).

From there, this article offers valuable insights into the state of the art of technology in entrepreneurial ecosystems, the systematic review with pre-defined criteria appears as the appropriate methodology to respond to the proposed objective.

Method

A systematic approach was used in this work. It is understood that this methodology allows systematizing the main concepts, theories, empirical results to build possible relationships in the current state of the art on the subject (Durach; Kembro and Wieland, 2017; Pollock and Berge, 2018). To go beyond descriptive analysis and survey of journals, etc., this article sought to analyze the main contributions found on technology in entrepreneurial ecosystems. The first step was to select the database (Web of Science) for building the systematization in Excel. After validating the database, content analysis was performed on the texts about the contributions.

Data collection and analysis

The web of science database was used to ensure the quality of the analyzed articles, a search was used with the term "Entrepreneurial Ecosystems" - in the title of each article in the database and the term "Technology" in the topic of each scientific article found in the database.

The steps below are essential to allow the replication of the research and future analyses, the following steps were performed:

1st Step: 143 articles from the main collection of the Web of Science were reached.

2nd Step: Disregarding dissertations, theses and congress articles. This step resulted in 79 articles from the main Web of Science collection.

3rd Step: Only the "Management" field of study was considered to refine the number of articles and direct the analysis only to this field. This step finally resulted in 43 viable and reviewable articles from the Web of Science core collection.

After surveying all articles, systematization was carried out in Excel, to allow content analysis with the following criteria: (a) pre-analysis and organization of resources, (b) definition of analysis categories, and (c) critical and reflective analysis of the results (Krippendorff, 2018).

This choice is based on the importance of content analysis to extract relevant and structured information from a set of unstructured data, such as the main contributions and gaps that are presented in an article (Wilson, 2016). In addition, to facilitate data coding, the NVIVO Software was used to code the main contributions and gaps in the work, allowing the categorization of texts (Walsh, 2003). The following table presents all the works analyzed, and we proceed to analyze the results.

Table 1. Articles analyzed in the systematic review (authors and journals)

Authors	Journal
Alaassar; Mention and Aas (2022)	Small Business Economics
Allahar; Haven and Sookram (2019).	Technology Innovation Management Review
Alves et al. (2019)	Revista de Administração de Empresas
Attour and Lazaric. (2020)	Small Business Economics
Audretsch et al. (2019)	The Journal of technology transfer
Autio et al. (2018)	Strategic Entrepreneurship Journal
Bessagnet; Crespo and Vicente (2021)	Technovation
Berman; Cano-Kollmann and Mudambi (2021)	Review of Managerial Science
Breznitz and Zhang (2019)	Industrial and Corporate Change
Buratti et al. (2022)	R&D Management
Cantner et al. (2021)	Small Business Economics
Condom-Vilà, P. (2020)	Journal of Evolutionary Studies in Business
Comeche (2018)	Tec Empresarial
Cuvero et al. (2022).	R&D Management.
Elia; Margherita, and Passiante. (2020)	Technological Forecasting and Social Change
Elia et al. (2021)	Administrative Sciences
Festa; et al. (2022)	Journal of Intellectual Capital
Gomes; Ferreira and Lopes (2023)	The International Journal of Entrepreneurship and Innovation
Hayter (2016)	Small Business Economics
Hemmert et al. (2019)	Asian Business & Management
Huang-Saad; Duval-Couetil, and Park (2018)	Journal of Enterprising Communities
Huang-Saad; Fay and Sheridan (2017)	The Journal of Technology Transfer
Kuratko et al. (2017)	Small Business Economics
Lai and Vonortas (2019)	Industrial and Corporate Change
Neumeyer; Santos and Morris (2019)	The Journal of Technology Transfer
March-Chordà; Adame-Sánchez and Yagüe-Perales (2021)	International Entrepreneurship and Management Journal
Malecki (2018).	Geography compass
Matt and Schaeffer (2018)	Journal of Innovation Economics & Management
Muldoon et al. (2022)	Review of Managerial Science
Prokop (2021)	Technovation
Prokop and Thompson (2022)	Small Business Economics
Ratten (2020)	Thunderbird International Business Review
Rocha and Audretsch. (2022)	The Journal of Technology Transfer
Roundy (2022)	Journal of General Management
Song (2019)	Small Business Economics
Spigel (2022)	Small Business Economics
Sussan and Acs (2017)	Small Business Economics
Oliver; Hogan and Albats (2020)	Triple Helix
O'Connor and Audretsch (2022)	Small Business Economics
O'Kane et al. (2021)	The Journal of Technology Transfer
van Rijnsvoever (2022)	Research Policy
Xie; Xie and Martínez-Climent (2019)	International Entrepreneurship and Management Journal
Xie; Wu and García (2021)	International Journal of Technology Management

Source: Authors

Analysis of Results

Initially it was possible to verify most articles published in *Small Business Economics*. It is an important journal that disseminates theoretical and empirical contributions related to entrepreneurship, small and medium-sized companies and the role of these companies in the economy.

The journal covers a wide range of topics, including business strategies, innovation, finance, internationalization, public policy, small business growth and performance. Therefore, it is possible to infer that since 2016, the journal has taken a great interest in technological issues involving entrepreneurial ecosystems. Based on the analyzed articles, it was possible to identify four categories of main theoretical and empirical contributions:

Types of settings and structures of entrepreneurial ecosystems

Understanding the dynamics of entrepreneurial ecosystems is essential to identify how different elements interact and influence the entrepreneurial environment (Condom-Vilà, 2020). This category of contribution highlights the importance of exploring the interaction between different types of configurations and actors (Prokop and Thompson, 2022), such as: Industrial Clusters; Incubators and Technology Parks; Supporting Institutions, Universities and Governments (Alaassar, Mention and Aas, 2022; Berman, Cano-Kollmann and Mudambi, 2021; Bessagnet, Crespo and Vicente, 2021). Understanding how these actors interact and relate to each other is crucial to promoting entrepreneurial development (Rocha and Audretsch, 2022; Buratti et al. 2022).

And in this sense, among the main works that approach the theme, Alves et al. (2019) discuss the configurations of knowledge-intensive entrepreneurial ecosystems, Audretsch et al. (2019) address the economic, technological, and social impacts of entrepreneurial ecosystems and their configurations, Malecki (2018) provides an overview of entrepreneurial ecosystems and their relationship to entrepreneurship, and Matt and Schaeffer (2018) explore building entrepreneurial ecosystems conducive to entrepreneurship. entrepreneurship from the ground up.

Role of academic institutions

The role of academic institutions in entrepreneurial ecosystems is of paramount importance for economic development and dissemination of research on the subject (Festa et al. 2022).

In general, all over the world universities are centers of knowledge and research generation, they explore new ideas, discoveries and innovations that have the potential to revolutionize the business world. Regarding this type of contribution, we saw that Allahar and Sookram (2019) discuss universities as centers of entrepreneurial ecosystems, Hayter (2016) investigates the role of knowledge intermediaries within a university entrepreneurial ecosystem, Breznitz and Zhang (2019) discuss the growth of startups by university students based on business acceleration and Comeche (2018) presents an innovation model within a university, in search of improvements and anchor points.

In short, when analyzing the literature on the subject, it appears that the role of academic institutions in entrepreneurial ecosystems is extremely important for boosting innovation and facilitating technology transfer (Comeche, 2018; Prokop, 2021; O’Kane et al. 2021).

Digital Transformation

Understanding and analyzing the impacts of digital transformation has become increasingly relevant in entrepreneurial ecosystems. The digitization of processes, the adoption of advanced technologies and the integration of digital solutions have significant impacts on operational efficiency, and on the way, actors relate to each other within an ecosystem (Cuvero et al. 2022; Zhang, van Gorp and Kievit,2022).

In this sense, Autio et al. (2018) examine digital and spatial affordances in the genesis of entrepreneurial ecosystems, Bouncken, and Kraus (2022) provide an integrated view of the importance of digital means of relationships between actors in an ecosystem, Elia et al. (2020) discuss how digital technologies and collective intelligence are reshaping the entrepreneurial process and Song (2019) explores the possible reconfigurations that clearly lay the groundwork for sustainable digital development.

The authors reinforce that through digital incorporation and data analysis, companies can collect valuable information about consumer behavior, market trends and individual preferences. This strongly helps in developing the ability to quickly adapt to market demands, which is essential for success in a complex environment such as an entrepreneurial ecosystem (Elia, Margherita and Passiante, 2020; Elia et al. 2021). The actors involved in an ecosystem need to be willing to adopt a digital mindset, invest in appropriate technology and promote a culture of innovation and adaptability (Sussan and Acs, 2017).

Internationalization and diversity

Recent studies reinforce the complexity and need for ecosystems to be culturally diverse (Hruskova, 2020). This search for internationalization and diversity are two fundamental aspects in entrepreneurial ecosystems. By looking for opportunities beyond borders, entrepreneurs can access new markets, increase their customer base and take advantage of the competitive advantages offered by different regions, such as qualified labor, natural resources or tax incentives (Gomes, Ferreira and Lopes, 2023; Lai and Vonortas, 2019).

This diversity encompasses both cultural diversity and diversity in terms of gender, age, education and professional experience. Having a diverse team brings different perspectives, complementary skills and greater ability to solve complex problems on a global level (O'Connor and Audretsch, 2022), especially the global problems raised in the sustainable development goals (van Rijnsoever, 2022).

Therefore, in the content analysis, it was found that the empirical and theoretical contributions are presented by Hemmert et al. (2019), who analyze the distinctiveness and diversity of entrepreneurial ecosystems in China, Japan and South Korea, March-Chordà et al. (2021) investigate locational factors for immigrant entrepreneurs in the main entrepreneurial ecosystems, Xie, Xie and Martínez-Climent (2019) contribute by presenting internal and external determinants in the context of emerging economies, show that the political environment is the most crucial factor that impacts the performance of the entrepreneurial ecosystem, Xie, Wu and García (2021) show that in countries where the dominant language structure incorporates high-gender linguistic structures, there is a greater negative effect on innovation performance and that also that this negative effect is stronger for women entrepreneurs than for men.

The final category on internationalization and diversity makes up an essential critical discussion within entrepreneurial ecosystems and opens space for a broad discussion on future paths, the subject of analysis in the next topic.

Analysis of future studies

After identifying these categories in scientific production in entrepreneurial ecosystems, we verified the main gaps and future directions suggested by authors in the area:

Table 2 - Mapping of future studies

Category	Authors	Future Directions
Configurations and Structures	Alves et al. (2019)	Focus on mechanisms for transferring knowledge and innovation between the agents involved
	Audretsch et al. (2019)	Expand understanding of the formation and evolution mechanisms of entrepreneurial ecosystems (emergence and developments)
	Buratti et al. (2022)	Understand how they evolve over time and what are the main drivers of these changes
Role of universities	Hayter (2016)	Explore how the interaction between ecosystem actors, such as teachers, researchers, students and companies, influences the performance of startups
	Huang-Saad; Duval-Couetil, and Park (2018)	Understand how universities contribute to the development of these ecosystems through technology transfer and the provision of entrepreneurial talent
	Matt and Schaeffer (2018)	Investigate strategies and policies that universities can adopt to promote an entrepreneurial culture among students by providing adequate support and resources
Digital Transformation	Song (2019)	Understand the characteristics of the digital environment, such as connectivity, the speed of technological change and new forms of interaction between actors
	Sussan and Acs (2017)	Investigate how digital technologies, such as artificial intelligence, the internet of things and blockchain, are shaping entrepreneurial ecosystems and impacting innovation processes and complex management.
Internationalization	Hemmert et al. (2019)	Explore the interactions between these entrepreneurial ecosystems and other ecosystems at a regional and global level, considering the flow of resources, knowledge and innovations
	Roundy (2022)	It is important to explore the unique characteristics of these ecosystems, such as networks of personal contacts, local communities
Diversity	Xie; Wu and García, (2021).	Understand how entrepreneurial ecosystems contribute to promoting a more inclusive and egalitarian environment for female entrepreneurs in emerging countries
	Xie; Xie and Martínez-Climent (2019)	Investigate the key elements that drive the emergence and development of these ecosystems, including factors such as digital infrastructure, human capital, government policies and strategic partnerships

Source: Author

Based on this mapping, we understand the need for a deeper analysis of the interaction between the different actors present in entrepreneurial ecosystems, especially on how these actors collaborate, exchange information and resources (in the short, medium and long term) (Audretsch et al. 2019; Alves et al. 2019; Buratti et al. 2022; Malecki, 2018).

The complexity is clear and should be seen as a motivation to expand studies on this type of ecosystem. As we have seen, it is important to investigate how digital technologies, such as artificial intelligence, the internet of things and blockchain, are shaping entrepreneurial ecosystems and impacting innovation processes, value creation and interaction between actors (Sussan and Acs , 2017; Song, 2019; Elia, Margherita and Passiante, 2020; Elia et al. 2021).

It is of paramount importance to investigate the unique characteristics of each ecosystem in terms of culture, institutions, government policies and market structures. Understanding these dynamics can contribute to promoting a more inclusive and egalitarian environment for female entrepreneurs in emerging countries, driving innovation and economic growth (Hemmert et al. 2019; Xie; Wu and García, 2021; Xie; Xie and Martínez-Climent, 2019).

Conclusion

The systematic review on entrepreneurship ecosystems with a technological perspective clearly demonstrates the main elements of theoretical and empirical contributions to the theme. Through content analysis, four major categories were found that relate to technology within this type of ecosystem, considered an unprecedented contribution to the theme, they are:

- Configurations and Structures
- Role of Universities
- Digital Transformation
- Internationalization and Diversity

The rapid evolution of technology facilitates the dynamics of the possibilities for these ecosystems to operate, but it is also related to other challenges found in the categories. From a practical point of view, it is essential that entrepreneurs adopt a critical and strategic approach to the use of technology in their ventures.

We understand that technology is present in all categories found, however, each one with its challenges, different contributions and present gaps. The theme is still new in the

literature and opens many possibilities to help in the development of entrepreneurial ecosystems.

In conclusion, the systematic review has limitations regarding the use of keywords, which end up limiting some studies that may be important for this type of analysis. It is suggested that researchers in the area use the insights raised in these surveys, and direct future studies with quality for the better development of the state of the art on entrepreneurial ecosystems.

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