Critical Success Factors for Strengthening the Relationship Between Incubators and Innovation Ecosystems

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Abstract: The relationship between business incubators and innovation ecosystems is crucial for fostering entrepreneurship and driving economic and technological progress. This study conducted a systematic bibliographic search to identify the critical success factors that influence this relationship, analyzing the role of business incubators in ecosystem innovation. The growing necessity to enhance incubators' strategic and operational effectiveness in generating, disseminating, and applying knowledge underscores the significance of this research. This study also highlights best practices and challenges in knowledge management faced by incubators. Additionally, by identifying critical success factors, it provides valuable insights into strategies that can strengthen collaboration among incubators, startups, and other ecosystem stakeholders. From a socio-economic perspective, the research underscores the role of incubators as key enablers of innovation and regional development. It also demonstrates how effective knowledge management can improve the sustainability and scalability of incubatees ventures. The findings aim to offer actionable recommendations for incubator managers and policymakers, reinforcing the role of incubators as catalysts for dynamic and resilient innovation ecosystems.

Keywords: Business incubators, Innovation ecosystems, Critical success factors, Business development

1. Introduction

Innovation ecosystems are composed of the interaction of various actors who collaboratively promote actions in favor of innovation. Based on a comprehensive analysis of the concept of an innovation ecosystem, it can be defined as a dynamic set of actors, activities, artifacts, institutions, and relationships, including both complementary and substitutive interactions, which are essential for the innovative performance of an actor or a population of actors (Granstrand & Holgersson, 2020).

In a given territory, city, or region, this interaction consists of multiple agents and their interrelations, which have the potential to transform localities into hubs of innovative entrepreneurship (Cai & Huang, 2018). In this context, business incubators play a crucial role by providing essential infrastructure and services to the ecosystem, enabling innovative entrepreneurship and establishing themselves as strategic elements of innovation ecosystems (Prokopenko, Eremenko & Omelyanenko, 2014; Peterková, Czerná & Zimmermannová, 2022; Matos, 2024).

Organizations that form part of the ecosystem's infrastructure, such as incubators, implement consulting and service provision activities, resulting in the generation of new viable proposals, the emergence of startups, the consolidation of emerging companies, and regional economic development (Peterková, Czerná & Zimmermannová, 2022; Silvestro et al., 2024).

In addition to providing favorable conditions for the creation and maintenance of innovative businesses, incubators leverage their networks to connect emerging enterprises with other ecosystem actors, fostering knowledge sharing and promoting innovation and entrepreneurship (Gerlach & Brem, 2015; Bereczki, 2019; Vaz et al., 2023; Silvestro et al., 2024).

In some cases, incubators play a fundamental role in driving the development of innovation ecosystems, particularly by boosting the business sector, acting as key agents in increasing urban competitiveness (Santos, 2022; Silvestro et al., 2022). For example, Santos (2022) highlights the role of a local incubator in strengthening the innovation ecosystem in the city of Coimbra.

Thus, the presence of incubators in an innovation ecosystem can enhance resources and make it more robust and resilient. However, it is essential to recognize that building an innovation ecosystem requires more than just financing accelerators or incubators. Innovative environments that operate without dense interconnection networks among entrepreneurs, coupled with a supportive and positive culture, have limited impact (Haines, 2016; Santos, 2022; Silvestro et al., 2022).

Although the literature highlights the positive effects of the relationship between the existence of incubators and the development of innovation ecosystems, there remains a gap in the systematization of the critical success factors influencing this relationship. Therefore, this study aims to analyze the critical success factors that strengthen the relationship between incubators and innovation ecosystems.

2. Methodological Procedures

To achieve the proposed objective, a systematic review was conducted covering the years 2014 to 2024, encompassing the last ten years of publications in the Scopus and Web of Science databases. The choice of these databases is justified by their representativeness in indexing high-impact journals. It is important to note that the research protocol followed was the one presented by Tranfield et al. (2003) and Kitchenham (2004).

Following this protocol, the search string used was: ("innovation ecosystem") AND ("business incubator"), identifying articles in titles, abstracts, and keywords from 2024 to 2014. The inclusion criteria applied were: (i) scientific articles written in English, (ii) published in peer-reviewed journals, and (iii) articles in which the search terms appeared simultaneously. Table 01 presents the results obtained from the search.

Table 1: Search Process

Steps Performed	Scopus	WoS	Total
Total searches	177	15	192
After removing redundancies	138	11	149
After reviewing abstracts, titles, and keywords, remaining articles	39	4	43

Source: Prepared by the authors.

Based on this, a review of the titles, abstracts, and keywords was conducted to assess the relevance of the selected articles, resulting in a final corpus of 43 documents used to construct the systematic review.

To analyze connections and the co-occurrence network, identifying relationships between keywords and key clusters, the VOSviewer software (version 1.6.18) was employed. This tool enabled the mapping of the theme's evolution, highlighting correlations such as keyword networks, the countries that most disseminate the topic, citation counts for theoretical support, and connections between articles, thus facilitating the construction of a synthesis to address the research problem.

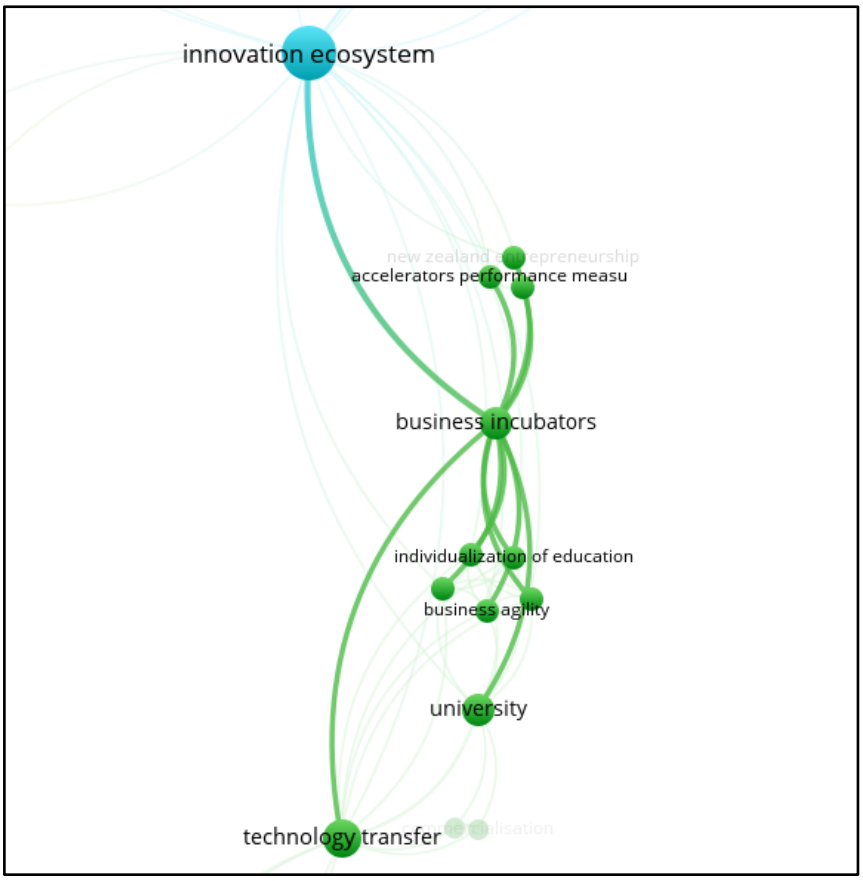
Additionally, a qualitative approach was applied, following the concept of Creswell (2010), which emphasizes the importance of purposeful selection of sources—including documents and visual materials—to support a deeper understanding of the problem and research question.

3. Presentation and Discussion of Results

This section presents the results obtained through the final textual corpus of this study. The analyses are based on the established protocol and research problem, providing a brief description of the sample.

3.1 Analysis of the Co-Occurrence Relationship Between Keywords

In Figure 01, the interaction formed by two major clusters is identified. The first cluster highlights the keyword "Innovation ecosystem" in blue, while the second cluster connects to "Business incubators" in green.



Source: Prepared by the authors.

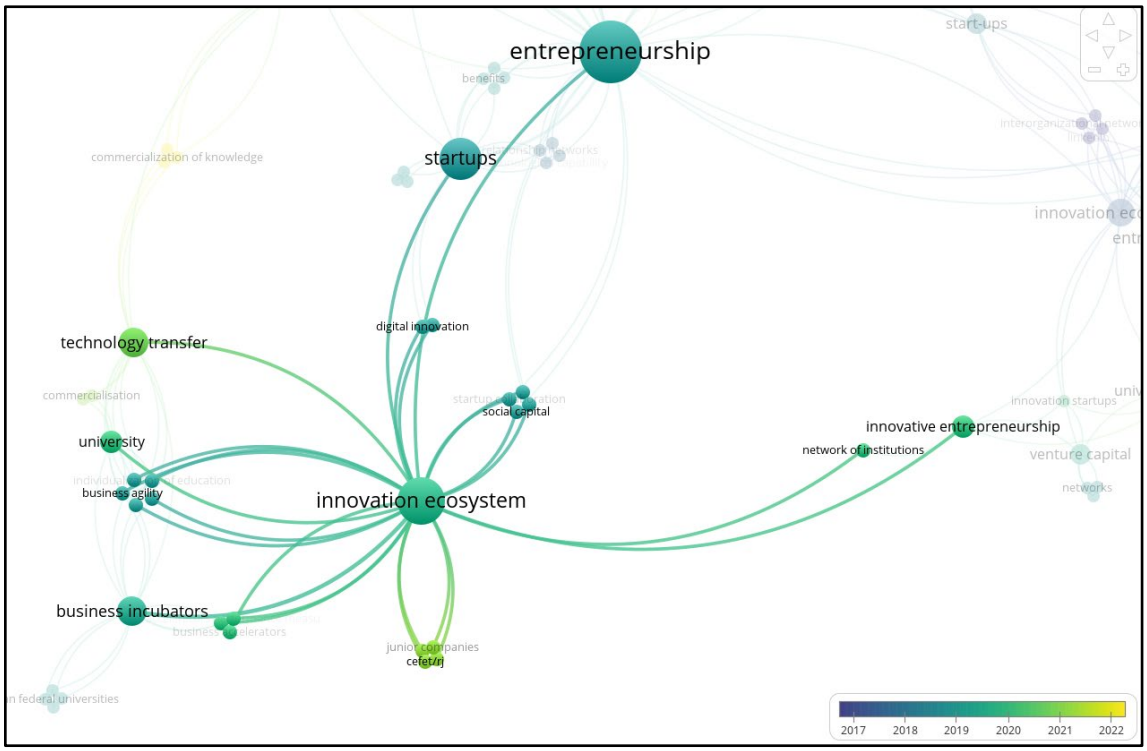
Figure 1: Keyword Co-Occurrence Network

The combination of these two clusters forms a crucial link for fostering and driving the entire ecosystem. When organizations are anchored in networks that collaborate towards common goals, the entire ecosystem benefits through innovation and entrepreneurship within their respective contexts (Machado Júnior, Felden & Teixeira, 2018).

Additionally, a well-developed innovation ecosystem provides the necessary infrastructure to support the evolution of actors in an entrepreneurial context (Romano, Passiante, Vecchio, & Secundo, 2014) and ensures continuous development for innovations (Gastaldi & Corso, 2016).

Furthermore, the innovation ecosystem comprises a network of entrepreneurs, mentors, service providers, and investors that can be leveraged to support the creation and development of businesses with more effective scalability (Haines, 2016). These businesses require new networks to facilitate knowledge transfer and optimize the use of available resources. Additionally, companies with superior open innovation niches within a given ecosystem gain advantages in technical resources and capital when they maintain strong ties with the innovation network (Xie & Wang, 2021).

Figure 02 illustrates the network formed by the year of publication of the keyword "innovation ecosystem", representing the first search string used in the research. As shown, it is directly connected to the "business incubator" keyword cluster, demonstrating important relationships between them. This connection also extends to other keywords such as "entrepreneurship," "technology transfer," "university," "business agility," "accelerators performance," "startups," "digital innovation," "social capital," "network of institutions," and "innovative entrepreneurship," all of which contribute to the development and findings of this research.



Source: Prepared by the authors.

Figure 2: Relationship Between Keywords and Year of Publication

The analysis of this figure highlights that when a network connects incubators and universities, there is a significant impact on economic viability, the entrepreneurial profile formation, and local and sectoral development. Moreover, this interaction facilitates the application and transfer of new technologies, promotes connections with research centers, and accelerates startup growth, contributing to job creation (Anprotec-MCTI, 2012).

In this context, incubators go beyond being shared workspaces; they function as networks of individuals and organizations that interact to ensure the smooth operation of the innovation structure. Their direct connection with universities and academic community members fosters the rapid transfer of knowledge and technology (Hackett & Dilts, 2004). Additionally, through structured methodologies, incubators strengthen interactions between resident companies and other ecosystem actors, promoting networking and collaboration (Felizola, Gomes & Almeida, 2019).

Thus, incubators play an essential role in supporting the innovation ecosystem, facilitating strategic partnerships, business model validation, training, and capacity building, and creating an environment conducive to innovation and sustainable growth (Mwandosya, Apiola & Lahde, 2016).

3.2 Analysis of the Relationship Between Incubators and Regional Economic Growth in the Innovation Ecosystem

Incubators serve as drivers of innovation for regional economic development and promote the sustainable growth of businesses. According to Barbe, Green, and Chang (2010), these institutions facilitate the creation of new companies and strengthen the entrepreneurial environment, directly impacting the local economy. By providing technical support, infrastructure, and strategic connections, incubators help entrepreneurs overcome initial challenges, enabling their businesses to achieve greater stability and market competitiveness (Ojaghi Mohammadi & Yazdani, 2019; Etzkowitz & Zhou, 2017; Ho & Yoon, 2022).

Additionally, incubators stimulate economic growth by enhancing competition and optimizing resource allocation. According to Ho and Yoon (2022), these institutions foster a dynamic ecosystem, allowing innovative startups to compete more effectively with established companies. This environment strengthens product and service diversification, creates new business opportunities, and increases productive efficiency. Another crucial factor is technology transfer and the development of new products, as highlighted by Ismail, Kamel, and Wahba (2018), who emphasize the interaction between incubators and universities as a catalyst for innovation and

patent generation. This relationship facilitates the co-commercialization of science, enabling startups to develop market-oriented technological solutions, thereby enhancing local economic competitiveness (Ojaghi Mohammadi & Yazdani, 2019; Etzkowitz & Zhou, 2017; Ho & Yoon, 2022).

Job creation is another significant impact of incubators. Mungila (2020) highlights that these institutions generate new employment opportunities by supporting startup growth and encouraging the hiring of skilled professionals, contributing to lower unemployment rates and human capital development. Furthermore, incubators act as key agents in identifying international market demands and structuring innovation networks, which are fundamental to the advancement of the entrepreneurial ecosystem (Ojaghi Mohammadi & Yazdani, 2019).

Santos (2022) and Ojaghi, Mohammadi, and Yazdani (2019) emphasize that maintaining and fostering innovation within startups is essential for global competitiveness. By promoting a collaborative and technology-driven environment, incubators ensure that new businesses gain access to strategic markets, solidifying their role as pillars of economic growth and sustainable innovation.

3.3 Analysis of the Role of Incubators in Boosting Companies Within the Innovation Ecosystem

Incubators play a strategic role in strengthening the innovation ecosystem by maintaining continuous relationships with their graduated companies, fostering a collaborative and supportive environment. This post-incubation support encourages knowledge exchange, expands networking opportunities, and enhances cooperation among entrepreneurs, companies, and academic institutions (Chan, Krishnamurthy & Sadreddin, 2022). This way, incubators not only drive startup development but also contribute to the sustainable evolution of the innovation ecosystem (Etzkowitz & Zhou, 2017; Ho & Yoon, 2022).

Beyond ongoing support, incubators facilitate startups' integration into business networks, providing access to investors, customers, and strategic partners. This assistance enables new ventures to position themselves more competitively in the market, adapt to sector demands, and ensure sustainable growth (Felizola, Gomes & Almeida, 2019). Thus, incubators act as bridges between startups and the market, ensuring that entrepreneurs have the necessary resources to establish their businesses (Santos, 2022; Mungila, 2020).

Another critical aspect is the business management support provided by incubators. Through mentorship programs, training, and consulting, they equip entrepreneurs with essential managerial and strategic skills. This guidance reduces risks and enhances the likelihood of startup success (Etzkowitz & Zhou, 2017). By strengthening the foundations of innovative businesses, incubators ensure their long-term sustainability.

Moreover, incubators serve as key environments for entrepreneurial development and innovation diffusion, offering structured programs and essential infrastructure to support new business development (Etzkowitz & Zhou, 2017; Ho & Yoon, 2022). Their initiatives create an environment conducive to experimentation, learning, and technological advancement, fostering entrepreneurial culture in the regions where they operate (Theodoraki, Messeghem & Rice, 2018). Thus, incubators transcend their role as business support entities, evolving into knowledge and innovation hubs (Etzkowitz & Zhou, 2017; Ho & Yoon, 2022).

Finally, the collaboration between incubators and other innovation ecosystem agents facilitates resource optimization, reduces redundancies, and strengthens connections among participants (Ho & Yoon, 2022). Studies indicate that engagement with incubators influences 70.6% of companies' technological capabilities, making it easier for them to integrate into financial and technological networks (Tumelero et al., 2018). Furthermore, these institutions foster new technological arrangements and open innovation processes, enhancing a more dynamic and competitive ecosystem for the development of innovative businesses (Mungila, 2020; Ismail, Kamel & Wahba, 2018; Castro et al., 2021; Santos, 2022).

3.4 Analysis of the Relationship Between Business Incubators and Universities in the Innovation Ecosystem

In academia, incubators support startups from their initial phases, promoting the practical application of knowledge generated in laboratories and research centers (Carvalho et al., 2020; Etzkowitz & Zhou, 2017; Ho & Yoon, 2022). This support allows the transformation of scientific discoveries into innovative and economically sustainable solutions, consolidating the concept of entrepreneurial universities (Castro et al., 2021; Barbe & Greene Chang, 2010; Cukier Fox & Rahnama, 2012; Etzkowitz & Zhou, 2017; Ojaghi, Mohammadi & Yazdani, 2019; Santos, 2022).

These institutions are crucial for developing entrepreneurial skills and attitudes in young people, preparing them for market challenges and fostering an innovation-oriented mindset (Carvalho et al., 2020; Etzkowitz & Zhou,

2017; Ho & Yoon, 2022). According to Cukier, Fox, and Rahnama (2012), in addition to training qualified professionals, entrepreneurial universities promote a culture of innovation, allowing students to acquire essential competencies for creating and managing new businesses.

Strengthening an innovative culture within the academic environment is a central aspect of this process. Hayter (2016) highlights that innovation does not occur secluded, but within a collaborative ecosystem that stimulates creativity and experimentation. By integrating entrepreneurship into university education, institutions empower students to transform ideas into sustainable businesses (Carvalho et al., 2020; Etzkowitz & Zhou, 2017; Ho & Yoon, 2022). Entrepreneurial learning, driven by academic initiatives, provides young people with essential practical experiences for their education. Mwandosya, Apiola, and Lahde (2016) emphasize that exposure to real market challenges facilitates the assimilation of management concepts and methodologies, a process enhanced by university incubators that offer support through internship and training programs.

Furthermore, universities play a role in generating spin-offs that strengthen the business ecosystem, as noted by Carvalho et al. (2020), who highlight that this interaction increases the competitiveness of emerging startups by providing access to contact networks, mentorship, and investment opportunities. The creation of technology hubs is also strategic for talent development and the growth of new specialized markets. Castro et al. (2021) also points out that these hubs foster employability in the technology sector, amplifying the impact of innovation in the market. Thus, business incubation emerges as a tool to support innovative businesses in their initial phases.

Finally, the continuous monitoring of entrepreneurs and startups by university incubators allows for the evaluation of their progress and the provision of strategic guidelines, ensuring their sustainability and consolidation within the innovation ecosystem (Ho & Yoon, 2022; Ismail, Kamel & Wahba, 2018; Castro et al., 2021; Tumelero et al., 2018).

3.5 Connection Axes Between Business Incubators and the Innovation Ecosystem

In summary, the articles identified a synergy among three axes that represent how incubators connect their hosted enterprises with the innovation ecosystem: support, network, and fostering.

Each axis seeks to elucidate the connections built by incubators to foster their activities in supporting entrepreneurs, as well as to demonstrate how this relationship occurs. These connections often serve to address existing gaps in the integration of ecosystem actors (Carvalho et al., 2020) with incubatees companies.

The "support" axis relates to how incubators, within their own structures and methods, corroborate these arrangements, utilizing their own operations to provide support to incubatees and connect them to ecosystem resources (Chan, Krishnamurthy & Sadreddin, 2022), and how, through these actions, they build an entrepreneurial culture (Cukier, Fox & Rahnama, 2012).

Business incubators play a strategic role in strengthening the innovation ecosystem by adopting diagnostic methodologies to assess the maturity of startups over time (Castro et al., 2021). This continuous monitoring allows emerging companies to receive adequate support at different development stages, from creation to growth. Furthermore, the presence of these startups boosts the local economy, attracting new commercial activities and generating jobs, which reinforces the positive impact of incubators on socioeconomic development (Barbe, Green & Chang, 2010).

Another essential factor is the support for market and product development, promoting innovation initiatives that connect entrepreneurs to different collaboration networks (Etzkowitz & Zhou, 2017). Through structured programs, incubators offer infrastructure, technical advice, and financial incentives, such as grants and tax benefits, facilitating the consolidation of startups (Ismail, Kamel & Wahba, 2018). Additionally, by providing benchmarking and sharing best practices, these institutions create an environment conducive to continuous innovation, allowing talents with promising ideas to access qualified support (Mwandosya, Apiola & Lahde, 2016).

Incubators also play an essential role in technology transfer and supporting the internationalization of startups (Tumelero et al., 2018). The provision of infrastructure and specialized technical knowledge enables startups to develop innovative and scalable solutions. Moreover, the strategic location of incubators favors access to emerging markets, attracting investments and expanding business opportunities (Carvalho et al., 2020). Thus, these initiatives drive the sustainable growth of startups and strengthen the competitiveness of the innovation ecosystem.

The "network" axis seeks to elucidate the channels through which incubators converge with other companies in their environment to maintain good relationships with their residents. Some means are presented by the authors, such as the construction of creative dialogues for relationship maturation. Another similar form of conversation between companies is that incubators build these creative conversations in their relationships between individuals and legal entities, in aspects with the convergence of interests (Tumelero et al., 2018).

Incubators play a strategic role in assisting international companies seeking to enter new markets, creating mutually beneficial partnerships with local and established companies (Chan, Krishnamurthy & Sadreddin, 2022). As bridges between different actors, they leverage talent and resources, influencing laws, values, and norms of the entrepreneurial ecosystem (Barbe, Green & Chang, 2010; Cukier, Fox & Rahnama, 2012). Furthermore, by subsidizing the growth stage of startups and providing access to strategic networks, incubators drive innovative development in various regions, with the support of municipalities, universities, and industrial associations (Etzkowitz & Zhou, 2017; Ojaghi, Mohammadi & Yazdani, 2019).

The connection between startups and innovation ecosystems occurs through the interaction between different actors, promoting strategic collaborations and facilitating open innovation processes (Santos, 2022; Ismail, Kamel & Wahba, 2018). Building solid networks is essential for developing partnerships, ensuring the exchange of knowledge between entrepreneurs, investors, mentors, and academic institutions (Ho & Yoon, 2022; Felizola, Gomes & Almeida, 2019). Additionally, the size of incubators and the breadth of their external networks directly influence investments in research and development, impacting the creation of new products and services (Mungila, 2020; Theodoraki, Messeghem & Rice, 2018).

Incubators also function as catalysts for regional innovation clusters, promoting peer interactions and strengthening collaboration within the ecosystem (Chan, Krishnamurthy & Sadreddin, 2022; Carvalho, Bersani, Maldaner & Piqué, 2020). The use of digital technologies and social media has been a strategy to expand external communication, connecting incubatees, investors, mentors, and the community in general (Tumelero, Sbragia, Borini & Franco, 2018). Thus, incubators not only strengthen local innovation but also create international networks that expand opportunities for startups and companies, promoting a dynamic and sustainable environment for business growth (Chan, Krishnamurthy & Sadreddin, 2022).

Finally, the "fostering" axis reports an important advancement for companies regarding financial capital. The authors report some ways in which incubators influence the financial aspect, leveraging the technological capacity of companies through their networks (Tumelero, Sbragia, Borini & Franco, 2018).

One of the ways is through connection points with other external companies, which help and contribute to incubatees obtaining funding, such as financial and social capital (Chan, Krishnamurthy & Sadreddin, 2022), both in the company's creation phase and in the validation of the business model (Carvalho, Bersani, Maldaner & Piqué, 2020), significantly contributing to the development of companies and the state's economy (Barbe, Green & Chang, 2010).

It also connects startups to external companies, facilitating access to essential resources such as financial capital, social capital, and market knowledge (Barbe, Green & Chang, 2010; Ojaghi, Mohammadi & Yazdani, 2019; Felizola, Gomes & Almeida, 2019; Ismail, Kamel & Wahba, 2018; Castro et al., 2021; Tumelero et al., 2018). This interaction enables incubatees to overcome challenges in the initial phases of creation and launch, ensuring strategic support for sustainable growth (Chan, Krishnamurthy & Sadreddin, 2022). Furthermore, the financial support offered through these connections strengthens the structure of startups, enabling investments in innovation and technological development (Carvalho, Bersani, Maldaner & Piqué, 2020).

The influence of incubators on the technological capacity of incubatees companies occurs through their financial and technological networks, promoting the absorption and application of new knowledge and innovative practices (Tumelero, Sbragia, Borini & Franco, 2018). This articulation allows startups to expand their competencies, reduce market entry barriers, and increase their competitiveness (Ojaghi; Mohammadi & Yazdani, 2019; Etzkowitz & Zhou, 2017; Ho & Yoon, 2022). Thus, incubators not only support structural provision but also drive the creation of a dynamic and collaborative ecosystem, important for investments in innovative businesses (Ojaghi, Mohammadi & Yazdani, 2019; Ho & Yoon, 2022).

4. Conclusion

When analyzing the results, critical relationship factors are highlighted in the research findings. Incubators play a strategic role in the dynamics of innovation ecosystems, structuring their actions around three main axes: support, network, and fostering. The support offered by incubators includes the provision of infrastructure,

specialized consulting, and access to financial incentives, creating a conducive environment for the consolidation and expansion of startups.

The construction and maintenance of solid networks are equally essential, as they allow the convergence of interests between different ecosystem actors, fostering collaboration and the development of new businesses. Financial fostering is a crucial factor for the sustainability of emerging companies, enabling incubators to act as catalysts for technological development and business competitiveness.

Moreover, the role of universities deserves attention, especially through the work of university incubators that can drive the transformation of knowledge into innovation through technology transfer and the internationalization of incubatees companies. Additionally, incubators contribute to the development of the ecosystem by generating jobs and providing access to strategic and international markets, connecting companies to global ecosystems.

Finally, the creation of networks between incubatees companies and post-incubation follow-up builds a unique innovation ecosystem and fosters a sense of belonging to a community, strengthening connections among participants in this environment. Understanding and fostering these factors that influence this relationship is essential for improving strategies and enhancing the synergy between incubators and innovation ecosystems.

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Ethics and AI Declaration: We declare that the present research utilized the VOSviewer software, version 1.6.18, for co-occurrence network analysis and mapping connections between keywords and bibliographic references. This software was used exclusively for organizing and visualizing data extracted from secondary sources, without any interference in the integrity or veracity of the analyzed information. Furthermore, we affirm that the study did not involve the direct or indirect participation of humans or animals in any of its stages. The entire methodology applied was based on public data and previously published documents, ensuring compliance with ethical principles and good research practices. Thus, the work fully adheres to the current ethical guidelines for studies of this nature.

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