LUIZ ANTONIO DE CAMARGO GUERRAZZI

The Role of Complementary Assets and the Institutional Context in the Performance of Business Incubators

UNIVERSIDADE DO ALGARVE

FACULDADE DE ECONOMIA

2025

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The Role of Complementary Assets and the Institutional Context in the Performance of Business Incubators

Doutoramento em Métodos Quantitativos Aplicados à Economia e à Gestão

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FACULDADE DE ECONOMIA

2025

Título da Tese

"**The Role of Complementary Assets and the Institutional Context in the Performance of Business Incubators**"

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"Estamos sós e sem desculpas. É o que traduzirei
dizendo que o homem está condenado a ser livre.
Condenado porque não se criou a si próprio; e,
no entanto, livre porque, uma vez lançado ao mundo,
é responsável por tudo quanto fizer."

Jean-Paul Sartre

Acknowledgements

To the Faculty of Economics of the University of Algarve, its director, Professor Efigénio da Luz Rebelo, Ph.D., and the professors.

To my invaluable supervisors: Professor Jorge Miguel Lopo Gonçalves Andraz, Ph.D., and Professor Dinis Manuel Correia Caetano, Ph.D.

To my former professors who cheered me up to follow the never-ending path of research.

To the leaders of the business incubators who collaborated with information without which this thesis would not exist.

To the friends who supported me with suggestions or words of motivation and perseverance.

To those who created obstacles to the completion of this thesis.

To Vanessa, my wife.

To all of them, thank you very much.

Resumo

Nesta tese, propomos analisar o desempenho das incubadoras de empresas. Para tal fim estudamos a efetividade do processo de incubação. Esta tese identifica o papel dos ativos complementares fornecidos pelas incubadoras de empresas durante o processo de incubação no fortalecimento das empresas incubadas, aumentando a sua probabilidade de sobrevivência, após deixarem a incubadora. Identificamos os tipos de ativos complementares proporcionados e a sua importância no desempenho das empresas na fase pós-incubação. Adicionalmente, identificamos a influência do ambiente institucional. Desse modo, associamos o desempenho das incubadoras ao sucesso das empresas após o período de incubação, na sua trajetória a solo no mercado. Para o efeito, realizamos três estudos distintos e interrelacionados, cada um com os seus próprios desenvolvimentos conceptuais e métodos. O primeiro estudo, usando técnicas bibliométricas, apresenta uma revisão da literatura sobre desempenho de incubadoras de empresas. Procuramos, neste estudo, identificar as principais formas de abordagem e as tendências sobre o tema. O segundo estudo investiga empiricamente os resultados do estudo anterior, usando uma amostra de incubadoras brasileiras e propõe-se identificar os ativos complementares que são relevantes à sobrevivência de empresas graduadas, isto é, pós-incubadas. O terceiro estudo compara incubadoras de empresas brasileiras e portuguesas quanto aos ativos complementares que fornecem no que diz respeito à sobrevivência das empresas graduadas. Optamos por testar a influência do ambiente institucional no segundo e terceiro estudos. No segundo estudo usamos o ambiente empreendedor das localidades-base das incubadoras e no terceiro estudo usamos, como pano de fundo, o perfil institucional de Brasil e de Portugal. Por fim, este estudo contribui para a estratégia empresarial e, mais especificamente, para o empreendedorismo, por associar o conceito dos ativos complementares oferecidos por uma incubadora de negócios à sobrevivência das empresas e, consequentemente, ao desempenho da incubadora. Também identificamos as características mais relevantes desses ativos e o papel do ambiente institucional. Adicionalmente, contribuímos para a prática ao identificar que alguns ativos complementares fornecidos durante a fase de incubação, têm um papel crucial na sobrevivência das empresas graduadas, aprofundando a análise sobre os critérios para a seleção de incubadoras de empresas e, ao proporcionar informação relevante para os gestores de incubadoras, através de diretrizes para a formulação de modelos de negócios.

Palavras-chave: Incubadora de empresas; ativos complementares; ambiente institucional; sobrevivência.

Abstract

In this thesis, we propose to analyze the performance of business incubators. To this end, we studied the effectiveness of the incubation process. This thesis identifies the role of complementary assets provided by business incubators during the incubation process in strengthening hosted companies, increasing their probability of survival after leaving the incubator. We identify the types of complementary assets provided and their importance in the performance of post-incubation companies. Additionally, we identified the influence of the institutional environment. In this way, we associate business incubators' performance with companies' success after incubating in their solo trajectory in the market. Specifically, we carried out three distinct and interconnected studies, each with its conceptual development and methods. The first study uses bibliometric techniques to review the literature on business incubator performance. In this study, we sought to identify the main approaches and trends on the topic. The second study empirically investigates the previous study's findings, using a sample of Brazilian business incubators, and aims to identify the complementary assets relevant to the survival of graduated companies, that is, post-incubated companies. The third study compares Brazilian and Portuguese business incubators regarding the complementary assets they provide for the survival of graduated companies. We chose to test the influence of the institutional environment in the second and third studies. In the second study, we used the entrepreneurial environment of the incubators' base locations, and in the third study, we used, as a backdrop, the institutional profile of Brazil and Portugal. Finally, this study contributes to business strategy and, more specifically, entrepreneurship by associating the concept of complementary assets offered by a business incubator with the survival of companies and, consequently, the incubator's performance. We also identify the most relevant characteristics of these assets and the role of the institutional environment. Additionally, we contribute to the practice by identifying that some complementary assets provided during the incubation stage play a crucial role in the survival of graduated companies, deepening the analysis of the criteria for selecting business incubators and, for business incubator managers, providing guidelines for formulating business models.

Keywords: Business incubator; complementary assets; institutional context; survival.

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List of Abbreviations

BI – business incubator
BIP – business incubator performance
Br - Brazilian
MDHI – municipal development human index
Pt - Portuguese

Chapter 1 – Introduction

Business incubators (BI´s) are instruments to facilitate entrepreneurship, and they have become a worldwide phenomenon in the last decades. Current research suggests that business incubators form an indispensable part of an entrepreneurial ecosystem for the promotion of start-ups across the global economy (Bala Subrahmanya, Satyanarayana, & Chandrashekar, 2019), as a tool for accelerating entrepreneurship (Hassan, 2020), and have emerged as highly popular methods for promotion of economic development in the industrialized and emerging economies (Kiran & Bose, 2020). According to Ratinho (2011), business incubators might provide different service portfolios to support new ventures, with a potential effect in long term survival and subsequent growth of nascent firms.

Although there is a broad literature on business incubators, the impact of the incubation period on the graduated ventures' survival remains unclear. Nevertheless, only since recently scholars have started to analyze BI´s while accounting for the institutional context, within which they operate (Dutt et al., 2016; Mrkajic, 2017). Focusing on the complementary assets provided by business incubators (Teece, 1986; Teece, 2006), this study aims to delve into the effects of these assets in mitigating threats of novitiate and size (Aldrich & Auster, 1986; Amezcua et al., 2020; Stinchcombe, 1965), after the incubation period. In this thesis, we propose that the new firms develop skills and capabilities during incubation stage, improving their likelihood of survival. Our research focus is to identify and assess the factors provided during incubation stage, that firms, after leaving the incubator, carry along and promote their survival and success. Accordingly, as one of the primary objectives of business incubators is the promotion of survivability and the positive development of their tenant firms, we take this indicator as a proxy to estimate business incubators' success (Vanderstraeten et al., 2016). We used a sample of graduated companies for a maximum of three years from Brazilian and Portuguese business incubators to conduct our research.

This thesis, therefore, is related to research on factors that enhance the survival and performance of newly founded firms. Survival research has been focused on large companies in general and there is a lack of research on small firms, in both professional and academic literature (Chowdhury & Lang, 1996; Collins, 2011; Lee, Kelley, Lee, Lee, 2012; Watson, & Everett, 1996). Despite growing research on factors affecting the survival of young and small firms, this research needs to be more elucidating and seems fragmented (Abatecola, Cafferata, & Poggesi, 2009; Franco & Haase, 2010; Gaskill, Auken & Manning, 1993). The study of

young firms is justified by their high mortality rates and socio-economic relevance (Aernoudt, 2004). They generate about 75% of jobs and participate in 30% of the gross domestic product in Brazil and 50% in Portugal, and almost half of the companies die after two years of foundation (data collected on the web, SEBRAE, and PORDATA, for Brazil and Portugal respectively).

After this introductory chapter, this thesis continues with a chapter focused on expanding the understanding of factors related to business incubators' performance. For this aim, we conducted bibliometric research using citation, co-citation and co-word analysis, through multivariate statistics and network analysis. Bibliometrics has been used to outline frontiers within broader fields through perceptions of their structure, conceptual networks, and most frequently researched themes; it also generates perceptions of research trends, and possible theoretical relationships can be extracted from bibliometrics (Zupic & Čater, 2015). Given its empirical nature, bibliometrics analysis can control idiosyncratic biases common to qualitative reviews without the help of empirical tools (Donthu et al., 2021).

In the third chapter, we borrow the concept of complementary assets (Teece, 1986) to delimit the services provided during the incubation period. We focus on the interface between the incubator and the graduated companies and the skills and capabilities these companies have developed through the complementary assets provided to them, strengthening them in their operation outside the incubation environment (Sydow, Schreyögg & Koch, 2009). Complementary assets are supporting resources, capabilities, or skills, physical, human, or organizational, that allow firms to gain benefits associated with a strategy, technology, or innovation (Reyes-Rodriguez & Ulhøi, 2022; Taylor & Helfat, 2009; Teece, 1986). It is an empirical study with a sample of Brazilian business incubators. As a proxy for the incubators' performance, it is used the survival rate of graduated firms and assess the entrepreneurial context's moderating role.

In the fourth chapter, we compare the success factors of Brazilian and Portuguese business incubators. Once again, we delve into the complementary assets provided during incubation stage and the graduated firms' survival rates. Jointly with the sample of Brazilian incubators, we use Portuguese incubators, keeping the same variables collected in both samples. The last chapter closes this thesis, summarizing the findings and the contributions.

This thesis contributes to the survival of newly founded firms and entrepreneurship in several ways. It deepens the knowledge on the role of business incubators through the assets provided to incubated firms. We intend to clarify the relative relevance among these assets to the survival and growth of graduated firms, meaning after they leave the incubator shelter. Also, we intend to contribute to the management of companies by elucidating what to search for in the incubation process and business incubator managers on what to offer to their tenants. Moreover, our contribution is extended to comparing incubation practices between Brazil and Portugal. In brief, we highlight how complementary assets behave as antecedents to incubators' success.

1.1 Business Incubators, incubation process and complementary assets: What are they?

1.1.1 Business Incubators and incubation process

Although the majority of incubators may influence entrepreneurial ventures (Mrkajic, 2017), universal definitions of Business Incubators remain elusive (Torun, 2018). When examining various definitions put forth in both academic and practical literature, it becomes apparent that these definitions do not only emphasize physical infrastructure but also encompass the provision of services and access to professional networks. Typically, business support services are characterized by the provision of physical facilities for incubated firms and are often regarded as the primary defining element (Nichlolls-Nixon et al., 2022; Peters et. al., 2004; Schwartz, 2013; Theodorakopoulos et al., 2014)

However, it is important to acknowledge that a Business Incubator extends beyond the mere provision of ready-to-use offices and shared building amenities (Aernoudt, 2004; Hackett & Dilts, 2004). The existing body of literature posits that business incubation encompasses additional dimensions, including the sharing of resources, business support services, and access to professional networks (e.g., Bergek & Norrman, 2008; Breivik-Meier, 2019; Liow & Wong, 2021; Nicholls-Nixon & Valliere, 2021; Peters, Rice, & Sundararajan, 2004). Practitioners frequently assert that business incubators yield a multitude of impacts at several levels (firms, communities, and science & technology), including enhancing firm performance and long-term viability, fostering economic growth, generating employment opportunities, and actively contributing to the cultivation of an entrepreneurial culture (OECD, 1997; UKBI, 2017).

Nowadays, the population of business incubators is remarkably heterogeneous, and several models, both practical and research-oriented, have been proposed to categorize them based on distinct characteristics. These characteristics encompass factors such as ownership

(Azadnia et al., 2022; Grimaldi & Grandi, 2005), management attributes (Aerts et al., 2007; Liow & Wong, 2021), strategic objectives (Hackett & Dilts, 2004; Souza et al., 2015; Theodoraki et al., 2022; von Zedtwitz and Grimaldi, 2006), competitive focus (Souza et al., 2015; von Zedtwitz & Grimaldi, 2006), and the array of services offered (Breivik-Meier, 2019; Liow & Wong, 2021; Theodorakopoulos et al., 2014). In fact, literature shows that business incubation encompasses a minimum of four dimensions, which include physical space (infrastructure), shared resources, business support services, and access to professional networks (e.g., Chan & Lau, 2005; Hackett & Dilts, 2004; Nicholls-Nixon & Valliere, 2021). Consequently, business incubation services encompass all the services extended to tenants that span these various dimensions.

The main objective of the business incubation process is to nurture emerging enterprises and entrepreneurs until they achieve sustainability as viable businesses (Azadnia et al., 2022). This support not only fosters job creation but also contributes to the generation of wealth (Lukeš et al., 2019). However, the extent of business incubators impact remains relatively underexplored due to the absence of a comprehensive framework for comprehending and evaluating their performance (Hackett & Dilts, 2004; Phan et al., 2005).

The incubation process aims to develop a newly founded firm to leverage its value and competitive advantage, thus reducing the risk of business failure (Ratinho, 2011). Incubators seek to strengthen incubated companies, helping company managers to better prepare themselves through administrative, financial and structural support, networking and access to lines of credit (Hackett and Dilts, 2004; Hackett and Dilts, 2008), as represented in Figure 1.1.

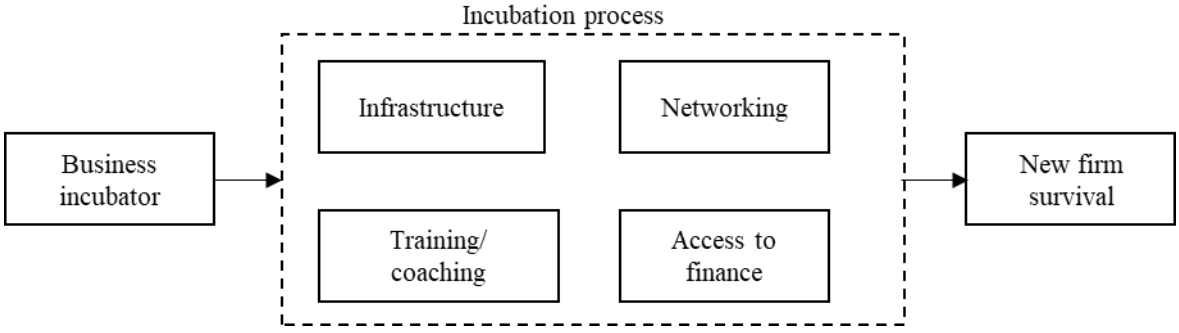

Figure 1.1 Incubation Process
Souce: own elaboration

1.1.2 Complementary assets

In this thesis, we employed the concept of complementary assets, which posits that these assets encompass the essential resources or capabilities, either physical, human, or organizational, intrinsic to a firm's operations (Teece, 1986). These assets play an instrumental role in facilitating the attainment of competitive advantages within a given process or operation (Teece, 1986). Complementary assets may assume a generic or specialized character. Generic complementary assets are not custom-tailored to meet the specific needs of a firm; instead, they are readily obtainable within the marketplace (Teece, 1986). In contrast, specialized complementary assets are distinct, valuable, and challenging to replicate, conferring a competitive edge (Barney, 1991; Teece, 1986).

In the broader context, intangible assets possess greater strategic significance than tangible assets, owing to their firm-specific nature, inherent difficulty in imitation, and limited substitutability (Barney, 1991; Teece, 1986). Complementary assets requisite for executing a novel entrepreneurial endeavor only sometimes exists a priori. However, they are established and configured as the entrepreneurial process unfolds, often as part of an incubation phase.

Examples of complementary assets encompass physical infrastructure, such as manufacturing facilities, expansive marketing and distribution networks, custom-tailored managerial practices, and access to cutting-edge technologies. Such assets tend to be scarce for nascent entrepreneurial ventures, particularly during the early stage of firms' development. This scarcity gives rise to two primary challenges. First, newly established firms frequently lack the financial resources that are essential for either procuring or building complementary assets. Initial resources may be directed towards forging critical business networks and delineating the roles and functional competencies of the core team to enhance the firm's prospects for survival. Second, the acquisition or development of these complementary assets is a time-consuming endeavor, a luxury seldom afforded to most new firms, unless they benefit from external support, such as participation in an incubator program.

1.2 Objectives and research questions

1.2.1 General and specific objectives

General objective

The main objective of this thesis is to research the performance of business incubators by identifying the influence of complementary assets provided during the incubation period,

on the survival of graduated firms and the moderation role of the institutional context in which they are inserted. We use the survival rate of graduated firm to assess incubators' success, once "one of the primary objectives of business incubators is the promotion of survivability and the positive development of their tenant companies" (Schwartz, 2009, p. 403).

Specific objectives

To fulfill the main objective, we formulated specific objectives to guide each study of this thesis.

1) To outline the fundamentals, boundaries, and trends of research on business incubators' performance, by analyzing the theme structure, relational networks between approaches that make up the theme structure, and the most frequently researched aspects. (Study 1)
2) To investigate the performance of business incubators through the role of complementary assets provided on the survival of graduated companies using a sample of Brazilian incubators and to determine if the entrepreneurial environment moderates this relationship (Study 2).
3) To compare what drives the performance of business incubators' practices in Brazil and Portugal (Study 3).

1.2.2 Research questions

Understanding how business incubators affect firms' survival after graduation is highly interesting for academics and practitioners. Nevertheless, the authors usually neglected the inherent influence of the BI´s on development of incubated firms and their business environment (Mrkajic, 2017). Despite the relevance of business incubation and the growth of research, literature needs to be more consensual on defining success and a set of indicators to measure performance efficiently (Dee et al., 2011; Theodorakopoulos et al., 2014; UKBI, 2012). Focusing on the complementary assets provided by business incubators, this study aims to delve into the effects of these assets in mitigating threats of novitiate and size through the constructs of the "liabilities of newness" and "liabilities of smallness" (Aldrich & Auster, 1986; Amezcua et al., 2020; Stinchcombe, 1965), after the incubation period. We propose that new firms be imprinted with these assets, strengthening their survival and bringing recognition and good performance to business incubators.

As business incubators are organizations with the main focus on supporting the creation and growth of new firms, the rate of graduated firms' survival and growth is a proxy to assess incubators' performance (Vanderstraeten et al., 2016). Hence, we will dive deeper into new

ventures' responses to complementary assets provided and assess the effectiveness of the incubation period. In sum, the overarching research question that guides this study and will drive the achievement of this thesis' objectives is as follows:

What role do complementary assets, and the institutional context play on incubators' performance?

From this general research question, we derive four questions that will be answered through the three studies proposed in this thesis and are paired with the specific objectives related above:

1) How is the structure of academic knowledge built, and what are the research trends on business incubators, complementary assets, and performance? (Study 1)
2) What is the role of complementary assets and the entrepreneurial environment, a proxy for the institutional context, in the performance of business incubators? (Study 2)
3) Are there any differences in incubation practices between business incubators in Brazil and Portugal? (Study 3)
4) How do the institutional environment and economic context affect the role of complementary assets on the performance of business incubators? (Study 3)

1.3 Theme justification

Business incubators have been vastly studied to date, and act as intermediaries that stand between incubated firms and their business environment (Mrkajic, 2017). Despite the relative maturity of business incubators, both as practice and as a research field, the evaluation of incubators' performance has been subject to fragmented and inconclusive research (Eveleens et al., 2017; Ratinho, 2011). Therefore, it is imperative to gain a comprehensive understanding of the drivers and antecedents that influence the performance of incubators in their mission to nurture newly established firms. While numerous studies have shed light on various facets of this matter (e.g., Allen & McCluskey, 1991; Barbero et al., 2012; Binsawad et al., 2019; Hong et al., 2019; Kiran & Bose, 2020; Messeghem et al., 2018; Mian, 1997; Rathore & Agrawal, 2021; Theodorakopoulos, 2014), significant gaps in our knowledge persist. A deeper exploration of the success factors inherent to business incubators holds paramount importance, given the pivotal social and economic roles played by new ventures. Business incubators, as their primary objective, endeavor to create conditions conducive to the survival and growth of

the tenant firms they host (Theodorakopoulos et al., 2014), through their contribution to tenants' development by helping them to solve their development problems (Ratinho, 2011).

1.4 Thesis structure

This research will be structured into five chapters which comprise three research studies as independent papers, distinguished by their approaches and methods but interconnected by their focus (see Figure 1.2).

Chapter 1 precedes the main chapters and provides a general introduction to the research theme and an outline of the overall research relevance, objectives, and questions, namely, the overarching research question and the specific research questions related to each paper. Further, this introductory chapter describes the structure of this thesis, including the titles of the three studies and their characteristics, such as individual objectives, and brief descriptions of their settings. Chapter 2 presents Study 1: "An Overview of Business Incubator Performance and a Roadmap for Future Research". Chapter 3 presents Study 2: "The role of different types of complementary assets and the entrepreneurial environment on the performance of Brazilian Business Incubators". Chapter 4 presents Study 3: "Determinants of Business Incubator Success in Diverse Institutional Environments: A Comparative Analysis of Brazil and Portugal". Finally, Chapter 5 concludes the thesis with a general discussion and conclusion summarizing the findings. We show our main contributions in this last chapter and point out limitations and future avenues for business incubators research. This structure is illustrated in Figure 1.2.

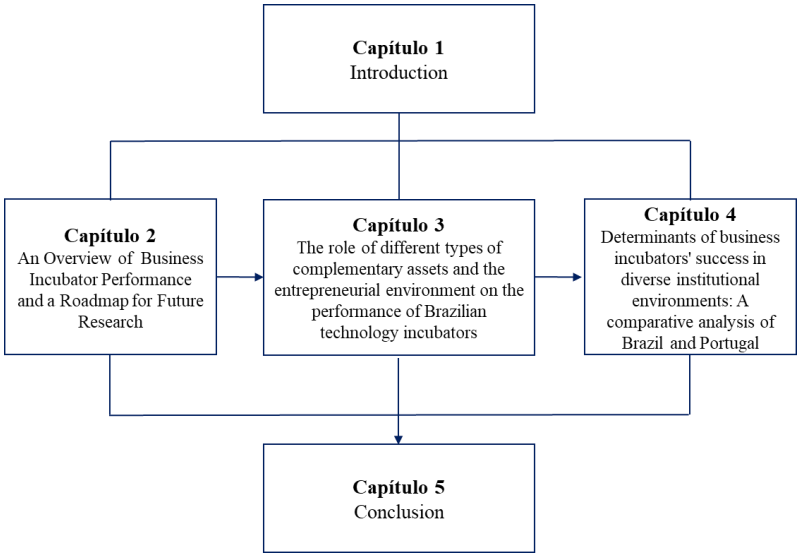

Figure 1.2. Thesis structure
Source:own elaboration

It is worth adding the following notes about each study:

1) Study 1 (Chapter 2) integrates a literature review. Due to the scarcity of literature putting together business incubators, complementary assets, and performance, we will conduct a bibliometric study of business incubators/performance and complementary assets/performance.

2) Study 2 (Chapter 3) has an empirical nature and intends to provide answers to the research question posed in this chapter about “The role of complementary assets and the entrepreneurial environment on the performance of Brazilian business incubators”.

3) Study 3 (Chapter 4), also with an empirical nature, places Brazilian and Portuguese incubators side-by-side to investigate whether these two countries' economic and institutional contexts impact on the drivers of business incubators' performance, evaluating whether there are differences in the drivers of such performance.

This thesis is based on a collection of three research papers (Chapters 2 to 4). Tables 1.1 to 1.3 bring detailed information about each paper.

Table 1.1. General information on Study 1

Research question **What role do complementary assets, and the institutional context play on incubators' performance?**					
General objective To identify the influence of complementary assets provided during the incubation period on the survival of graduated firms and the moderating role of the institutional context in which they are inserted.					
Specific objective To outline the fundamentals, boundaries, and trends of research on incubator performance by analyzing the theme structure, relational networks between approaches that make up the theme structure, and the most frequently researched aspects.					
Title "An Overview of Business Incubator Performance and a Roadmap for Future Research".					
Specific research question	**Hypotheses**	**Method**	**Sample collection**	**Analysis proceedings**	**Expected findings**
Study 1 – Chapter 2 How is the structure of academic knowledge built, and what are the research trends on business incubators, complementary assets, and performance?	[not applicable]	Bibliometric research.	The data were collected in the Web of Science and Scopus databases, using the keywords "incubator," and "performance" in the field Topic of the portal searching engine. The sample account with 299 documents.	1. Citation analysis. 2. Co-citation analysis. 3. Co-word analysis. 4. Relational network analysis. Software: SPSS BibExcel Ucinet	1. Approaches used to study the theme, meaning, the basis of the research on this theme. 2. Trends of research. 3. Suggestions for future studies. 4. Overlapping between the approaches used and the research trends

Source: own elaboration

Table 1.2. General information on Study 2

Research question **What roles do complementary assets, and the institutional context play on incubators' performance?**					
General objective To identify the influence of complementary assets provided during the incubation period on the survival of graduated firms and the moderating role of the institutional context in which they are inserted.					
Specific objective To investigate the performance of business incubators, through the role of complementary assets provided, on the survival of graduated companies, using a sample of Brazilian incubators. To determine if the entrepreneurial environment, a contextual characteristic, moderates the above relationship.					
Title "The Role of Different Types of Complementary Assets and the Entrepreneurial Environment on the Performance of Brazilian Business Incubators".					
Specific research question	**Hypotheses**	**Method**	**Sample collection**	**Analysis proceedings**	**Expected findings**
Study 2 – Chapter 3 What is the role of complementary assets and the entrepreneurial environment, a proxy for the institutional context, on the performance of business incubators?	The hypotheses investigated the impact of the complementary assets identified in the survey on the performance of the incubators, using graduated firms' rates of survival and growth. Also, we tested if the entrepreneurial environment moderates these relations.	Multiple linear regression with control variables and moderation tests.	Survey conducted with 109 Brazilian technology incubators.	Multiple linear regression. Moderation analysis. Software: SPSS	Factors that drive the success of incubators, regarding the nature of complementary assets offered.

Source: own elaboration

Table 1.3. General information on Study 3

Research question **What role do complementary assets, and the institutional context play on incubators' performance?**					
General objective To identify the influence of complementary assets provided during the incubation period on the survival of graduated firms and the moderating role of the institutional context in which they are inserted.					
Specific objective To compare what drives the performance of business incubators' practices in Brazil and Portugal.					
Title "Determinants of Business Incubator Success in Diverse Institutional Environments: A Comparative Analysis of Brazil and Portugal".					
Specific research question	**Hypotheses**	**Method**	**Sample collection**	**Analysis proceedings**	**Expected findings**
Study 3 – Chapter 4 Are there any differences in incubation practices between business incubators in Brazil and Portugal? What is the effect of the institutional environment and economic context on the role of complementary assets on the performance of business incubators?	The hypotheses investigated whether there is a difference in performance drivers between Brazil and Portugal, which present distinct institutional and economic contexts.	Cluster analysis and non-parametric mean-comparison test.	Samples with 109 Brazilian business incubators and 52 Portuguese business incubators.	Cluster analysis and Mann-Whitney U-tests. Software: SPSS	Discrepancies between business incubation practices in Brazilian and Portuguese incubators driving success.

Source: own elaboration

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Chapter 2 – An Overview of Business Incubator Performance and a Roadmap for Future Research[1]

ABSTRACT

Even though academic literature on business incubators has received significant attention, review studies on incubator performance still need to be made available. This paper fulfills this gap by employing 299 documents from the Web of Science database. This paper conducts a bibliometric analysis using citation, co-citation, and co-word techniques. The research findings depicted the main factors pointed out in the sample as drivers of incubator success through their tenants' survival and growth. These factors relate to tangible and intangible asset provision, such as shared physical structure, process and routine formalization, and networking activities. These factors enable firms to overcome the liabilities of newness and smallness. Further, the co-word analysis reveals that there are three trend fields of research on incubation success: (1) performance factors and conditions, (2) incubation process, and (3) networking-related aspects. These results contribute to stakeholders, academic scholars, policymakers, start-up owners, entrepreneurs, and practitioners by identifying aspects that should be present in the assessment and choice of a business incubator.

Keywords: business incubator performance; start-ups success; research trend; bibliometric; science mapping.

2.1. Introduction

Start-ups are significant economic and social development drivers due to job creation and wealth generation, and their survival and growth are entrepreneurial success points. Incubating new firms is among the key initiatives aimed at stimulating and promoting entrepreneurship and economic growth, both in developed and developing countries (Bala Subrahmanya, Satyanarayana, & Chandrashekar, 2019; Innocenti & Zampi, 2019; Mrkajic, 2017). Accordingly, the main focus of business incubators is the promotion of survivability and development of their tenant firms (Peters, Rice, & Sundararajan, 2004; Theodorakopoulos, Kakabadse, & McGowan,

[1] Submitted to Scientometrics – Scopus Q1 / JCR Journal Impact Factor: 3.5.

2014). For these reasons, business incubators have an essential role in nurturing the creation and growth of successful entrepreneurial firms.

Newly founded firms suffer from several imperfections related to market entry and lack the necessary resources to develop. The higher mortality rate among new and small companies, when compared to mortality among established and mature firms, can be explained by the notions of ‘liability of newness’ (Stinchcombe, 1965) and ‘liability of smallness’ (Freeman, Carroll, & Hannan, 1983). Incubators may influence entrepreneurial ventures, help new firms overcome the threats these liabilities bring, and increase their perspective of survival. An incubator's bridging role assists entrepreneurs in reaching and accumulating the resources that they need (Mrkajic, 2017). (Mrkajic, 2017). By providing resources, social and management training and counseling, and supporting a network environment, business incubators give hatched firms advantages that should increase their survival relatively to independent newly founded firms. Start-up managers, entrepreneurs, and collaborators recognize that being part of a network environment and training and counseling on managerial issues are essential for new firms. These conditions can contribute to new firms’ need for diversified resources, such as formalized learning, lower transaction costs, and valuable alliance partners.

The research field of incubators and incubators' performance has become fragmented and unsystematic due to the increasing proliferation of literature (Eveleens, van Rijnsoever, & Niesten, 2017; Friesl, Ford, & Mason, 2019; Theodorakopoulos et al., 2014). This study outlines the fundamentals, boundaries, and trends of research on incubator performance by analyzing its structure, relational networks between the adopted approaches that make up the theme structure, and the most frequently researched aspects. Therefore, this research aims to organize and integrate the scholarly knowledge base related to incubators' performance and explore the incubation process's main characteristics and impact on performance. With this study, we explored the gap that emerged from the suggestion of Azadnia et al. (2022) on the need for an appropriate, robust, and useable framework that can measure business incubators' performance.

To this end, we conducted a bibliometric analysis, which has been commonly used to review a particular research field (Mongeon & Paul-Hus, 2016) and provide a research agenda (Guo et al., 2019). This bibliometric analysis can also be helpful for practitioners (entrepreneurs, new venture managers, and founders) who require information on what factors should be

considered to assess incubators' performance. It is worth noting that, as the focus of an incubator is to increase the probability of a firm's survival and development, tenants' success during and after the hatched period is vital to assess incubators' performance.

Differing from literature reviews, which represent a qualitative approach, bibliometric analyses are quantitative methods (Zupic & Čater, 2015) and, therefore, are considered more objective (Chubin & Garfield, 1980; Donthu et al., 2021; Marx & Bornmann, 2016). Thus, we opt for a quantitative approach in the empirical analysis, in order to build a conceptual framework. Considering the study focus, the research questions are: (1) what factors influence incubator performance and start-up performance? (2) what are the theoretical foundations of incubators' performance research? (3) what are the trends in incubation performance research?

The remainder of this paper is organized as follows. In the next section, we provide a brief overview of the literature about business incubator performance, followed by a section describing the method. In section 4, we present the findings from the bibliometric analysis and summarize the results with a conceptual framework. We then discuss how business incubators achieve performance and present a research agenda.

2.2. Literature review

2.2.1 Business incubator performance

Business incubators aim to assist in developing new firms (Theodorakopoulos *et al*., 2014; Ratinho & Henriques, 2010; Kiran & Bose, 2020). In the business incubation industry, "business incubator" has become an umbrella term that refers to various initiatives designed to support start-ups (Aernoudt, 2004; Vanderstraeten & Matthyssens, 2012. The objective of business incubation process is to increase the survival and growth of small and newly founded enterprises, overcoming the 'liability of newness' (Stinchcombe, 1965) and 'liability of smallness' (Aldrich & Auster, 1986; Hannan & Freeman, 1984), which refers to the high risk of failure new and small firms face after the market entry because they do not possess the resources they need to survive (Stinchcombe, 1965; Hannan & Freeman, 1984).

During the incubation period, tangible and intangible assets are provided to ensure the survival and growth of firms, once the lack of resources restricts these firms' success. (Wu, Wang, & Tsai, 2019). So, business incubators help to establish new firms and assist survival during their

early age, when they are more vulnerable to failure. By the creation of supportive entrepreneurial environments, incubators have helped start-ups to increase their survival rates (Aernoudt, 2004; Aerts, Matthyssens, & Vandenbempt, 2007; Bala Subrahmanya et al., 2019). As business incubators and companies located within incubators are intrinsically linked, incubators' success depends on their tenants' success, which is incubators' primary focus, considering the social and economic role of new firms.

The research assessing an incubator is fragmented with a set of suggested criteria. Researchers have used various indicators to assess the effectiveness of business incubation. For instance, Allen and McCluskey (1991), in their US study on 127 business incubators, used three indicators: occupancy, jobs created, and firms graduated. Phillips (2002), in line with Allen and McCluskey (1991), adopted another three indicators. These were the tenants revenues, number of patent applications per firm, and number of discontinued businesses. Later, Chan and Lau (2005) adopted nine indicators: advantages from pooling resources, sharing resources, consulting services, positive effects from a higher public image, networking advantages, clustering effects, geographic proximity, cost subsidies, and funding support. Binsawad, Sohaib, and Hawryszkiewycz (2019) suggest tenant firms' survival and growth, such as sales growth and employment growth, and Vanderstraten, van Witteloostuijn, Matthyssens, and Andreassi (2016) point to a mixed indicator composed of survival of graduated firms and sales and employee growth, following Schwartz (2009), who posits that the primordial measure is, accordingly to one of the primary objectives of business incubators, the promotion of survivability and the positive development of their tenant firms.

2.2.2 Bibliometrics on business incubators

An exhaustive search on the two most relevant academic databases (Scopus and Clarivate's Web of Science) enabled the identification of 18 literature reviews using bibliometrics techniques on incubators or during incubation (Table 2.1). These studies investigated, with incubators as a central focus, business models, social entrepreneurship, and innovation ecosystem, among other topics.

Reinforcing the fact that the body of literature on business incubators is fragmented (Phan, Siegel, & Wright, 2005), these papers investigated various aspects. Science parks, university, and virtual incubators were pointed as trends in the incubation ecosystem. They are the focus of several

papers of this sample (Amaral et al., 2020; Cunnigham et al., 2022; Diez-Vial & Montoro-Sanchez, 2017; Minguillo et al., 2015; Mora-Valentin et al., 2018), exploring a possible and unique business model to support incubators (Vaz & Teixeira, 2022), or the incubation process focusing performance drivers (Le & Pham, 2022), the antecedents, characteristics and trends of the process (Deyanova et al., 2022; Albort-Moran & Ribeiro-Soriano, 2016).

Taking part in an incubator promotes capacities that strengthen new firms, such as promoting networks among pairs or fostering entrepreneurial competencies (Fernandes & Ferreira, 2022; Iscaro et al., 2019; Reis et al., 2021). Some papers explored the role of the economic context in the incubation process in South Africa (Bucci & Marks, 2022) and in emerging economies (Nabarreto et al., 2022; Peely & Ribeiro, 2020).

We found just one study among these 18 papers in the sample (Gurgel, Vieira, & Rodrigues, 2017) focusing on incubators' performance (Table 2.1). Gurgel et al. (2017) is a conference paper not published in any peer-reviewed journal. It brings a descriptive view of several works in the study sample of 150 documents. Their study finishes with a suggestion for future research, which was extracted from the sample's most relevant papers, classified by their respective h-index.

The heart of this bibliometric research lies in scrutinizing the incubators' performance drivers, strategies, and best practices that underpin these incubators' success. We aim to uncover the critical elements that influence the long-term viability and impact new firms that have journeyed through incubation process programs. By understanding the intricacies of business incubator performance, identifying the structure of the field, and the research trends, we hope to contribute to the refinement and enhancement of these vital support systems, ultimately fostering a more robust and prosperous entrepreneurial landscape. In this paper, we delve into the fragmented world of business incubation performance, aiming to unlock the keys to entrepreneurial success. Table 2.1 summarizes the 18 bibliometrics studies found in the databases, their focus and findings, work samples, and applied techniques. It can be noticed that the approaches to performance drivers are fragmented and that there is a gap in the literature on business incubators' performance researched in a more holistic approach.

Table 2.1. Summary of bibliometrics on incubators

Title/authors	Study focus	Research objectives	Key findings	Method (sample, period)
Vaz, R., de Carvalho, J.V., Teixeira, S.F. (2022). Towards a Unified Virtual Business Incubator Model: A Systematic Literature Review and Bibliometric Analysis. *Sustainability, 14*(20), 13205.	Business model	Bibliometric analysis and systematic literature review on virtual incubators business models, and how the virtual incubators organize and operate to support tenants during the creation and development of their businesses.	There is no unified model to support virtual business incubators' operation during the entire incubation process of their tenants, and it is generally adopted three different perspectives: business organization and management perspective, information, and communication systems perspective, associated with the incubators' managers.	Bibliometric analysis, 152 documents – Systematic Literature Review, 12 incubators.
Bucci, A., Marks, J. (2022). Social entrepreneurs' learning experience in South African incubators. *Africa Journal of Management, 8*(3), 374-398.	Social entrepreneurship	This study aims to explore aspects of entrepreneurs' learning experience in South African incubators.	The social entrepreneurs' learning experience occurs through examples from the best performers entrepreneurs, used to transform themselves and their ventures. Although this drives social entrepreneurs to prioritize profit, taking them apart from the basic needs of social businesses.	Phenomenological approach with 11 social incubators. This paper is not properly, a bibliometric, but a collection of cases studies.
Nabarreto, R.L, Cirani, C.B.S., da Costa, P.R. (2022). The Innovative Ecosystem of Startups in Emerging Economies. *Journal of Management and Technology, 22*(3), 268-284.	Innovation ecosystem	To identify the main themes addressed by the literature related to the innovation ecosystem in start-ups and how they relate to the economies of emerging countries.	The bibliometric investigation pointed out entrepreneurship, incubators, and venture capital as the three main themes addressed by the literature.	Bibliometrics – citation and co-citation techniques, 544 papers.
Le Vu, T., Pham, H.-H. (2022). A Bibliometric Analysis of Studies on 'Start-up Success' Covering the Period 1981-2019. *Journal of Scientometric Research, 11*(2), 212-225.	Start-up success	This work accomplishes the research gap by delving into start-up success.	The science mapping identified six main topics of start-up success (1) Business in General, (2) Start-up Ecosystem, (iii) Academic Start-up, (iv) Drivers of Start-up Success, (v) Resources for start-up, and (vi) Start-up Model.	Bibliometrics using citation analysis and co-citation analysis with 1554 papers from Scopus dataset between 1981 and 2019.

Title/authors	Study focus	Research objectives	Key findings	Method (sample, period)
Coronel-Pangol, K., Orden-Cruz, C., Paule-Vianez, J. (2022). Bibliometric analysis of alternative financing for entrepreneurship. *Cuadernos de Gestión, 22*(2), 167-182.	Financing for entrepreneurs	This work aims to provide a view of the evolution of the relationship between entrepreneurship and alternative financing within three-time brackets (1975-1999, 2000-2010, and 2011-2020). Further, this paper identifies current trends and future lines of research.	Venture capital and business angels were identified as primary financing sources for entrepreneurs, being the most studied, especially since 2000. Future research should focus on incubators in universities and research centers, corporate governance, and developing this type of financing in emerging countries.	Bibliometrics using 1916 documents from Web of Science.
Deyanova, K., Brehmer, N., Lapidus, A., Tiberius, V., Walsh, S. (2022). Hatching start-ups for sustainable growth: A bibliometric review on business incubators. *Review of Managerial Science, 16*(7), 2083-2109.	Incubator field research	The paper aims to organize and integrate the academic literature relating to incubators and to explore the main antecedents and characteristics of incubators, as well as their impact and performance.	The authors propose a framework for future research on business incubators.	Bibliometric study using bibliographical coupling and performance analysis in the timespan between 1987 and 2019, with 194 documents.
Cunningham, J.A., Lehmann, E.E., Menter, M. (2022). The organizational architecture of entrepreneurial universities across the stages of entrepreneurship: A conceptual framework. *Small Business Economics, 59*(1), 11-27.	Organizational architecture of universities incubators	The paper focuses on how entrepreneurial universities are organized to support the different stages of entrepreneurship (latent, emergent, launch, and growth).	Three types of entrepreneurial universities were identified. There are organizational units that focus exclusively on exploration stages of entrepreneurship, others that deal with exploration and exploitation stages, and those considering all stages of entrepreneurship.	Qualitative analysis of the literature.
Dabić, M., Marzi, G., Vlačić, B., Daim, T.U., Vanhaverbeke, W. (2021). 40 years of excellence: An overview of Technovation and a roadmap for future research. *Technovation, 106*(4), 102303.	Overview of Technovation publications	The study is about the 40th anniversary of Technovation and provides, using bibliometrics analysis, an overview of the journal's publications since its beginning in 1981.	The paper identifies the primary contribution sources in terms of authors, universities, and countries, the most cited articles, and the thematic profile of the collection of Technovation's published papers through bibliometric analysis. Finally, this study points out growing research trends and proposes future research.	Bibliometrics techniques using 1905 papers published between 1981 and 2019.

Title/authors	Study focus	Research objectives	Key findings	Method (sample, period)
do Amaral, M.G., da Hora, A.L.F., Messias, N.R., de Andrade Cunha, L., Maia, J.S. (2020). A Divergent Research Agenda: Academic and Professional Publications on Science, Technology and Innovation Parks. *Triple Helix Journal, 7*(1), 1-37.	Publications on innovation parks	The paper compares the publications on Science, Technology, and Innovation Parks, from academic researchers and technical publications to increase the comprehension of who they are and what they are researching.	Results show that academic authors dealt with conceptual themes, while managers and technicians emphasized operations issues.	Bibliometrics indicators using 177 papers from Web of Science, covering publications from 2007 to 2018.
Fernandes, A.J., Ferreira, J.J. (2022). Entrepreneurial ecosystems and networks: A literature review and research agenda. *Review of Managerial Science, 16*(1), 189-247.	Entrepreneurial ecosystems	The paper aims to identify, analyze and discuss the main trends in academic literature on the topic of entrepreneurial ecosystems and networks.	The analysis clustered the researched literature into four groups, named by the authors as (1) Context and Cooperation; (2) Established Networks; (3) Challenges to the Affirmation of Minorities; (4) Formal Structures. Further, it identifies the most relevant trends in the literature.	Bibliographic coupling and keywords co-occurrence, using 65 articles from Web of Science, with no temporal restrictions.
Reis, D.A., Fleury, A.L., Carvalho, M.M. (2021). Consolidating core entrepreneurial competence: Toward a meta-competence framework. *International Journal of Entrepreneurial Behavior & Research, 27*(1), 179-204.	Entrepreneurial competence	The focus is to identify the most relevant entrepreneurial competence by mapping the current body of literature and proposing a framework connecting this competence.	A list of 98 entrepreneurial competence was identified, and among these, 33 were considered core competence due to consensus in the literature. This list opens avenues for future research. Further, the study proposes a framework of competence.	Bibliometrics using mapping analysis and content analysis of 109 documents published until 2019, collected in Web of Science and Scopus databases.
Pecly, P.H.D., Ribeiro, P.C.C. (2020). Entrepreneurship in BRICS and cultural dimensions. *Brazilian Journal of Operations & Production Management, 17*(2), 1-18.	Entrepreneurship in the BRICS	The study aims to clarify the reasons for low expression of entrepreneurship activities in the BRICS through a review of the literature on cultural dimensions (Hofstede, Trompenaars and Hampden-Turner, Hall, Schwartz, and Kluckhohn and Strodtbeck).	The findings show that entrepreneurial attitudes are affected by the cultural traits of the nation, by the most influential productive sector in the economy, by the nature of entrepreneurship (opportunity or necessity), and by the characteristics of the authors studied.	Bibliographic and document study using Web of Science and Scopus databases.

Title/authors	Study focus	Research objectives	Key findings	Method (sample, period)
Iscaro, V., Castaldi, L., Joshi, R., Turi, C. (2019, September). Network-based incubators: An introduction to the case of i2c and research agenda. In 12th Annual Conference of the EuroMed Academy of Business.	Network-based incubators	The paper aims to delve into the literature dealing with business incubators with a focus on network-based incubators.	Due to a large number of papers, the contributions result in voluminous and fragmented research streams. Thus, a literature review is crucial in synthesizing past research findings and advancing lines of research.	Case study and systematic literature review.
Mora-Valentín, E.M., Ortiz-de-Urbina-Criado, M., Nájera-Sánchez, J.J. (2018). Mapping the conceptual structure of science and technology parks. *The Journal of Technology Transfer, 43*(5), 1410-1435.	Structure of science and technology parks	The two objectives of the paper are (1) through descriptive bibliometric analysis, identify the number of authors per work and year, number of papers per author, top authors, author affiliations, and top journals, and (2) using a co-word analysis to identify the conceptual structure of the field.	The results of the co-word analysis reveal five main thematic trends: innovation, park, interorganizational relationship, spillover and technology.	Bibliometrics using descriptive and co-word analysis. The sample comprised 447 works collected from the Web of Science database.
Diez-Vial, I., Montoro-Sanchez, A. (2017). Research evolution in science parks and incubators: Foundations and new trends. *Scientometrics, 110*(3), 1243-1272.	Foundations of parks and incubators	The paper aims to proceed with a quantitative review of the existing literature on parks and incubators to identify their foundations, adopting a longitudinal perspective.	The paper identified the foundations of science parks and incubation research from a longitudinal perspective, using five periods of time, considering the interactions that exist between different research lines. Second, an agenda for future research was proposed.	Bibliographic coupling, using 318 documents from the Web of Science database, with no restriction of publication time.
Gurgel, G.M.M., Vieira, F.D., Rodrigues, C.S. (2017). Performance of business incubators: A systematic review of evidence. In 2017 International Conference on Engineering, Technology and Innovation (ICE/ITMC), pp 852-857.	Incubator performance	The paper aims to clarify what has been done concerning business incubation and new research trends.	The findings identified several factors, such as intense local economic activity and scientific production, that seem to be contextual factors for improved incubators' performance.	150 papers extracted from the Web of Science database, from 1990 to 2017.

Title/authors	Study focus	Research objectives	Key findings	Method (sample, period)
Albort-Morant, G., Ribeiro-Soriano, D. (2016). A bibliometric analysis of international impact of business incubators. *Journal of Business Research, 69*(5), 1775-1779.	International impact of business incubators	The paper's focus is to provide insights into nature and trends of research on business incubators.	The findings were several bibliographic descriptive indicators, such as eminent authors, year of publication, countries with the highest productivity rate, journal with most published research, language, type of research, and research area. The paper identified the lack of articles on incubators and reinforced the fragmented nature of the field.	Bibliometric analysis of 445 studies on business incubators, from Web of Science, between 1985 and 2015.
Minguillo, D., Tijssen, R., Thelwall, M. (2015). Do science parks promote research and technology? A scientometric analysis of the UK. *Scientometrics, 102*, 701-725.	Promotion of research and technology on science parks	Through a bibliometric analysis with academic studies, this paper investigates the creation of new knowledge by research-intensive organizations located on different support infrastructures across the UK.	Support infrastructures seem not helping to reduce the uneven development and geographic distribution of research-intensive industries in the UK.	Descriptive bibliometrics analysis with 9771 documents.

Source: own elaboration.

2.3 Method

Through multivariate and network analysis, we conducted a bibliometric analysis using citation, co-citation, and keyword co-occurrence techniques. Bibliometric analyses have been used to outline frontiers within broader fields, through perceptions of the field's structure, networks, and most frequently researched themes. It also generates perceptions of research trends (Habib & Afzal, 2019), and possible theoretical relationships can be extracted from bibliometric studies (Donthu et al., 2021). Thus, bibliometrics are inherently empirical, and they have crucial advantages as we can control idiosyncratic biases, which are common to qualitative reviews carried out without the help of empirical tools (Zupic and Čater, 2015).

2.3.1 Data collection and sampling

We collected the data from the Web of Science (WoS) because of its broad coverage of social science publications. The WoS database was chosen due to its prestige and extent of coverage (Zupic & Čater, 2015), ensuring both the quality and diversity of the articles collected. Firstly, we identified the search term to be used for our empirical study. The search was conducted using the keywords "incubat*" and "perform*", using the asterisk to allow wording variations in titles, abstracts, and keywords. We collected all existing works until October 2022 exclusively from the Business and Management area. The initial search identified 408 documents.

To mitigate eventual collecting bias and ensure the validity and reliability of the selected studies, we set criteria for choosing the final sample (Vogel & Güttel, 2013). The works had to contain concepts of business incubator performance as central themes or related to other theoretical approaches. The articles also had to be related to the literature on entrepreneurship or concerned with incubation ecosystem aspects. We read the title, abstract, and introduction of each document to validate the sample and, when necessary, we read the documents in full to clarify any doubts. During the sample validation, we categorized the articles into works on business incubator performance. Although some papers used science parks instead of incubators, we kept them in the sample, as they assessed performance related to science parks through the business incubators within them. To ensure reliability, we conducted a new search in the Scopus database and obtained a 90% overlap with the articles collected in the Web of Science database, which we further added to our sample. The final sample had 299 documents.

2.3.2 Analysis procedures

We used a combination of approaches and software for bibliometric analysis, such as VOSviewer v1.6.16, Bibexcel, Ucinet, and IBM SPSS v26.

Firstly, we outlined a series of bibliometric activity and impact indicators to identify the publication evolution through time and the most cited papers (Persson, Danell, & Schneider, 2009). Next, we proceed with a more in-depth analysis by applying advanced methods to the dataset (Zupic and Čater, 2015), namely co-citation analysis, relational networks, and co-word analysis. The steps used to conduct this bibliometric analysis are as follows and are summarized in Figure 2.1.

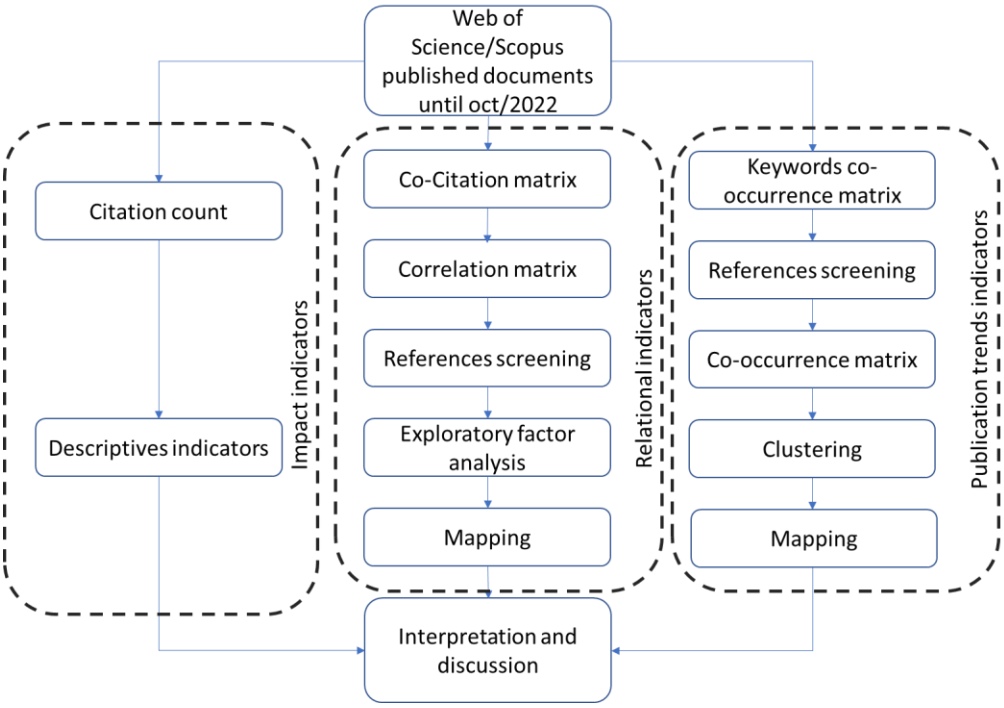

Figure 2.1. Research flow
Source: own elaboration

Further, we generated data on the publication evolution and the most cited works. The latter process, citation analysis, ensures further validity of the findings, as it helps to identify conceptual relationships among the approaches and avoids distortions in the co-citation analysis. We used the sample in fullness, as co-citation is intended to establish connections between the most cited authors, to identify patterns and relational knowledge structures. The sample included around 20.300 citations.

We adopted a pruning protocol (Zupic & Čater, 2015) to achieve clarity. We specified a minimum number of shared references between a document and a minimum number of other documents, and a minimum number of citations by the whole sample. Only publications at or above these thresholds were considered. By varying these limits within a range of values, we adjusted the resolution of the method to reduce the sample without being too reductive (Vogel & Güttel, 2013). We considered references with

up to 25 citations, reducing the sample to 50 references and up to 2.500 citations or 12.3% of the total sample, consistent with Lotka´s Law (Lotka, 1926). This principle states that a relatively small number of cited articles (approximately 5%) would represent the intellectual structure that delimits the preferred theme in a given area of knowledge (Lotka, 1926; Nath & Jackson, 1991). It is worth noting that to homogenize the cited references, and further refine our selection, we reviewed the name of the journals since many of them had different abbreviations, deleted the second surname of the authors, and converted titles and names of authors into lowercase. We employed Bibexcel software (Persson et al., 2009) to conduct the bibliometric analysis.

Citation analysis was the first procedure to be conducted. It is based on counting how often works are cited in a sample, assuming that authors cite works relevant to their research, with the most cited authors having the most significant influence on the theme. It provides evidence of the knowledge base of a field and measures the influence of publications (Zupic & Čater, 2015).

Co-citation analysis, the second procedure adopted, measures how frequently a pair of articles are jointly cited in a sample, assuming that frequently co-cited works represent related concepts. Therefore, it is a measurement of proximity between works, evoking conceptual knowledge sub-fields, and their relationships, i.e., the intellectual structure of a knowledge base (Vogel & Güttel, 2013). To perform co-citation analysis, we conducted an exploratory factor analysis (EFA) (Zupic & Čater, 2015). We extracted a bibliographical reference co-occurrence matrix using Bibexcel and converted it into a Pearson correlation matrix during the factor analysis procedure. We extracted the factors using the principal components method, with Varimax rotation (Lin & Cheng 2010) and Kaiser normalization in SPSS, v26. Further, we retained the documents with a factor loading greater than or equal to 0.40. The underlying principle of EFA is that articles with related conceptual aspects compose the same factor, identifying structural knowledge sub-fields (Lin & Cheng 2010). Then, we defined the names of the factors for co-citation based on a detailed analysis of the shared content of the grouped works.

Finally, we conducted a keywords co-occurrence analysis that, by identifying the most common words in a field of research (Callon, Courtial, Turner, & Bauin, 1983; Callon, Courtial, & Laville, 1991), allows for the identification of the conceptual structure of the research field under investigation and the most critical literature trends on this topic (Cobo, López-Herrera, Herrera-Viedma, & Herrera, 2011; van Eck & Waltman, 2019).

We used an additional clustering method to gauge robustness (Vogel & Güttel, 2013). Network analysis enables the mapping and the visualization of the structure of a field through a network diagram,

with the nodes representing the publications and the ties representing their proximity relationship. We included a network analysis using the Ucinet software (Borgatti, Everett, & Johnson, 2013) with the same matrix used in the exploratory factor analysis and provided several relational networks measures like centrality, cohesion, and density. The mapping technique used for keyword co-occurrence analysis is embedded in VOS-viewer software.

2.4 Results

In this section, we present the results of the bibliometric analysis of incubators' performance, following the research questions about the factors that impact incubator performance and, hence, start-ups performance, the theoretical foundations of the body of literature on incubators' performance and the trends in business incubation performance research. Figure 2.2 shows the number of documents and the years of publications. Two hundred ninety-nine papers have been published since 1989, the first year brought by the Web of Science database search, with 53% published in the last five-year period (2018–2022). The most significant development of this line of research has occurred since 2014, with an amount of 247 works, representing 82% of the papers that have been published. Longitudinal analysis shows that the knowledge base of business incubator performance might be divided into three periods: the first period comprises 1989-2006, with 20 works published, 7% of the sample; the second period is from 2007 to 2014, with 58 studies published, or 19% of the total; the third period comprises the period 2015 to 2022, during which 221 papers on incubator performance were published (74% of the sample of 299 studies). The year with the highest number of publications in the whole period is 2019, with 38 published studies.

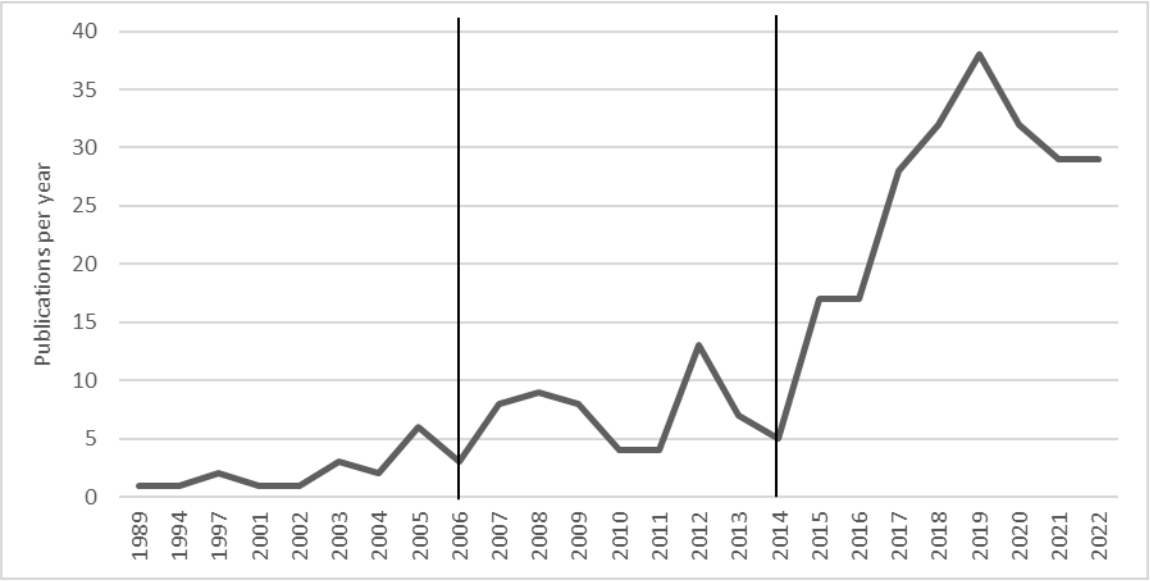

Figure 2.2. Temporal evolution of publications
Source: own elaboration

Table 2.2 presents the top 12 most influencing outlets for incubators' performance. These 12 outlets published 121 documents, equivalent to 40% of the total 299 documents that make up the research sample. To better characterize the sources, some bibliometric indicators were included, like the journals' quartiles and the number of citations (as pointed out in https://jcr.clarivate.com/jcr/home).

The most prolific journals on incubators´ performance are the Journal of Technology Transfer, Technovation, and Technological Forecasting and Social Change, with 64 published documents (21% of the sample) and about 45 thousand citations. Further, the sample comprises 63 journals with less than five published papers and 30 conference proceedings, evidence of the wide dispersion of journals and the fragmentation of focus on approaches to business incubator performance.

Table 2.2. Journals by number of papers publishing business incubators' performance research

Journal	Articles	Journal impact factor (*)	Citations (*)	Quartile (*)
Journal of Technology Transfer	29	5.337	5148	Q2
Technovation	23	11.373	9106	Q1
Technological Forecasting and Social Change	12	10.884	31070	Q1
R & D Management	8	5.962	5155	Q2
Research Policy	8	9.473	34484	Q1
International Journal of Innovation Management	7	n/a	2273	Q3
Small Business Economics	7	7.096	14093	Q2
European Journal of Innovation Management	6	4.750	2933	Q2
Technology Analysis & Strategic Management	6	3.745	4379	Q2
Entrepreneurship and Regional Development	5	6.408	4703	Q2
International Entrepreneurship and Management Journal	5	6.150	4194	Q2
International Journal of Innovation	5	n/a	144	Q4
63 Journals with < 5 articles				
30 Conferences proceedings				

(*) 2021 Clarivate´s Journal Citation Reports™
Source: own elaboration

2.4.1 Citation analysis

A point of interest when considering the authors in a field is the citation count, they have obtained. Such information is presented in Table 2.3, which shows the most cited works for the whole period under analysis, up to 10% of the sample, or 29 citations. Considering only the ten most-cited, out of all references employed by the 299 documents of the sample, the first two top-cited documents delve into investigating the best practices offered to lead to performance (Bergek & Norrman, 2008; Hackett &

Dilts, 2004a), with 110 and 105 citations respectively. Both studies propose a research agenda to identify the best practices incubation process. The need for clarity on the approaches regarding performance is discussed by Phan et al., (2005). The variety of incubating organizations (Business Innovation Centers, University Business Incubators, Independent Private Incubators, and Corporate Private Incubators) and an assessment of incubating models are investigated to identify the different services each offers to assist emerging ventures by providing support services and assistance in developing their business (Grimaldi & Grandi, 2005).

Three papers delve into the advantages of being hatched in a science park due to the proximity of several facilities, like positive effects from relational symbiosis through networking with stakeholders, economies of scope, and clustering benefits (Bøllingtoft & Ulhøi, 2005; Chan & Lau, 2005; Colombo & Delmastro, 2002). The importance of networking between incubators and business angels to encourage entrepreneurship and strengthen business incubator performance is discussed in Aernoudt (2004). Bruneel, Ratinho, Clarysse, and Groen (2012) deal with new business models adopted by incubators, adjusting their value proposition and incorporating new incubation paradigms as an answer to new types of start-ups. Finally, Aerts et al. (2007) deal with the relationship between tenant screening practices by European business incubators and performance.

Briefly, these studies deal with the need to identify the relevance of performance among the services provided during incubation. The underlying logic is that the excellent performance of start-ups, whether while incubated or after graduation, is crucial to the success of an incubator.

Table 2.3. Citation analysis

Title	**Authors**	**Total citations**	**%**
Incubator best practice: A framework	Bergek and Norrman (2008)	110	37%
A systematic review of business incubation research	Hackett and Dilts (2004a)	105	35%
Science parks and incubators: observations, synthesis and future research	Phan et al (2005)	102	34%
Business incubators and new venture creation: an assessment of incubating models	Grimaldi and Grandi (2005)	95	32%
How effective are technology incubators?: Evidence from Italy	Colombo and Delmastro (2002)	89	30%
The networked business incubator—leveraging entrepreneurial agency?	Bøllingtoft and Ulhøi (2005)	88	29%
The Evolution of Business Incubators: Comparing demand and supply of business incubation services across different incubator generations	Bruneel et al (2012)	78	26%
Critical role and screening practices of European business incubators	Aerts et al (2007)	77	26%
Assessing technology incubator programs in the science park: the good, the bad and the ugly	Chan and Lau (2005)	77	26%

Title	Authors	Total citations	%
Incubators: tool for entrepreneurship?	Aernoudt (2004)	73	24%
Assessing value-added contributions of university technology business incubators to tenant firms	Mian (1996)	68	23%
Assessing and managing the university technology business incubator: an integrative framework	Mian (1997)	66	22%
Co-production of business assistance in business incubators: an exploratory study	Rice (2002)	60	20%
Networked incubators	Hansen et al (2000)	59	20%
High tech start-ups in University Science Park incubators: The relationship between the start-up's lifecycle progression and use of the incubator's resources	McAdam and McAdam (2008)	58	19%
Structure, policy, services, and performance in the business incubator industry	Allen and McCluskey (1991)	52	17%
Revisiting incubation performance: How incubator typology affects results	Barbero et al (2012)	50	17%
The role of incubators in the entrepreneurial process	Peters et al (2004)	49	16%
The role of incubator interactions in assisting new ventures	Scillitoe and Chakrabarti (2010)	49	16%
Science Parks and the growth of new technology-based firms, academic-industry links, innovation and markets	Löfsten and Lindelöf (2002)	48	16%
University–incubator firm knowledge flows: assessing their impact on incubator firm performance	Rothaermel and Thursby (2005a)	47	16%
Science parks and the development of NTBFs—location, survival and growth	Ferguson and Olofsson (2004)	45	15%
Understanding a new generation incubation model: The accelerator	Pauwels et al (2016)	44	15%
Incubator firm failure or graduation? The role of university linkages	Rothaermel and Thursby (2005b)	43	14%
Technology Business Incubation: An overview of the state of knowledge	Mian et al (2016)	42	14%
Cooperation patterns of incubator firms and the impact of incubator specialization: Empirical evidence from Germany	Schwartz and Hornych (2010)	42	14%
Spinning out new ventures: a typology of incubation strategies from European research institutions	Clarysse et al (2005)	41	14%
Start-ups: Business incubation and social capital	Tötterman and Sten (2005)	41	14%
Firm resources and sustained competitive advantage	Barney (1991)	38	13%
Specialization as strategy for business incubators: An assessment of the Central German Multimedia Center	Schwartz and Hornych (2008)	38	13%
Service-based differentiation strategies for business incubators: Exploring external and internal alignment	Vanderstraeten and Matthyssens (2012)	36	12%
Are service profiles incubator-specific? Results from an empirical investigation in Italy	Von Zedtwitz and Grimaldi, R. (2006)	35	12%
The role of science parks and business incubators in converging countries: Evidence from Portugal	Ratinho and Henriques (2010)	33	11%
Business incubation centers and new firm growth in the Basque country	Pena (2004)	32	11%

Title	Authors	Total citations	%
Architecting gloCal (global–local), real-virtual incubator networks (G-RVINs) as catalysts and accelerators of entrepreneurship in transitioning and developing economies: lessons learned and best practices from current development and business incubation practices	Carayannis and Von Zedtwitz (2005)	31	10%
Do different types of incubators produce different types of innovations?	Barbero et al (2014)	31	10%
Organizational sponsorship and founding environments: A contingency view on the survival of business-incubated firms, 1994–2007	Amezcua et al (2013)	30	10%
A real option-driven theory of business incubation	Hackett and Dilts (2004b)	29	10%

Note. % refers to the total sample of 299 papers.
Source: own elaboration

2.4.2 Co-citation analysis

The factors resulting from the EFA represent the theoretical approaches used in the sample. For documents with significant loadings in over one factor, we considered their maintenance in the factor with the highest loading. (Shafique, 2013), although it could conceptually contribute to another factor (Zupic & Čater, 2015). Three articles did not achieve the minimum loading of 40%: Löfsten and Lindelöf (2002), Storey and Westhead (1994), and Siegel, Westhead, and Wright (2003), and were excluded from the final sample (Shafique, 2013). The final co-citation sample contains 47 documents.

The EFA identified three factors with an explained variance of 77,6%. The factor loadings, placed right after the identifying reference, represent how much the given article belongs to the factor (Table 2.4). The result of the Kaiser-Meyer-Olkin test (KMO = 0.74) was considered excellent (Tabachnick & Fidell, 2001), and the Bartlett sphericity test ($\chi 2 = 3165$; $p < 0.001$) demonstrated the adequacy of the sample for factor analysis. The factors are named after reading the papers to identify the theory addressed and how they relate to each other (Ramos-Rodríguez & Ruíz-Navarro, 2004). The three factors resulting from this factorial analysis were named as follows: (1) determinants of incubator performance, (2) business network, and (3) new trends.

Table 2.4. Co-citation factor analysis

Factor 1 - Determinants of incubator performance		Factor 2 - Business network		Factor 3 - New trends	
Ferguson and Olofsson (2004)	0.84	Hughes *et al.* (2007)	0.71	Theodorakopoulos *et al.* (2014)	0.82
Rothaermel and Thursby (2005b)	0.76	Soetanto and Jack (2013)	0.67	Amezcua *et al*. (2013)	0.75
Rothaermel and Thursby (2005a)	0.76	Allen and McCluskey (1991)	0.67	Mian *et al*. (2016)	0.73

Mian (1996)	0.72	Rubin *et al*. (2015)	0.67	Pauwels *et al.* (2016)	0.70
Barney (1991)	0.67	Vanderstraeten and Matthyssens (2012)	0.66	Schwartz (2013)	0.68
Mian (1997)	0.67	Hackett and Dilts (2008)	0.66	Barbero *et al.* (2014)	0.67
Chan and Lau (2005)	0.66	Von Zedtwitz and Grimaldi (2006)	0.63	Hackett and Dilts (2004b)	0.59
Colombo and Delmastro (2002)	0.66	Bøllingtoft (2012)	0.62	Voisey *et al*. (2006)	0.57
McAdam and McAdam (2008)	0.65	Peña (2004)	0.62	Barbero *et al.* (2012)	0.56
Schwartz (2009)	0.65	Scillitoe and Chakrabarti (2010)	0.62		
Peters *et al*. (2004)	0.63	Carayannis and von Zedtwitz (2005)	0.62		
Ratinho and Henriques (2010)	0.62	Schwartz and Hornych (2008)	0.61		
Vohora *et al*. (2004)	0.61	Bruneel *et al.* (2012)	0.61		
Schwartz and Hornych (2010)	0.60	Hansen *et al.* (2000)	0.60		
Phan *et al*. (2005)	0.56	Tötterman and Sten (2005)	0.59		
Bøllingtoft and Ulhøi (2005)	0.52	Aernoudt (2004)	0.57		
		Aerts *et al*. (2007)	0.54		
		Rice (2002)	0.54		
		Clarysse *et al*. (2005)	0.52		
		Grimaldi and Grandi (2005)	0.51		
		Bergek and Norrman (2008)	0.50		
		Hackett and Dilts (2004a)	0.50		
% Variance explained	27.64		26.73		23.18
% Variance accumulated	27.64		54.37		77.55
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	0.74				
Approx. Chi-Square	3165				
Df	1081				
Sig.	0.000				

Source: own elaboration

For a better definition of the factors identified in the EFA and to support the co-citation analysis, we produced a relational network and identified each factor by a different geometric shape in the network. The co-citation network is shown in Figure 2.3. We used the 47 documents with a higher degree of interrelations.

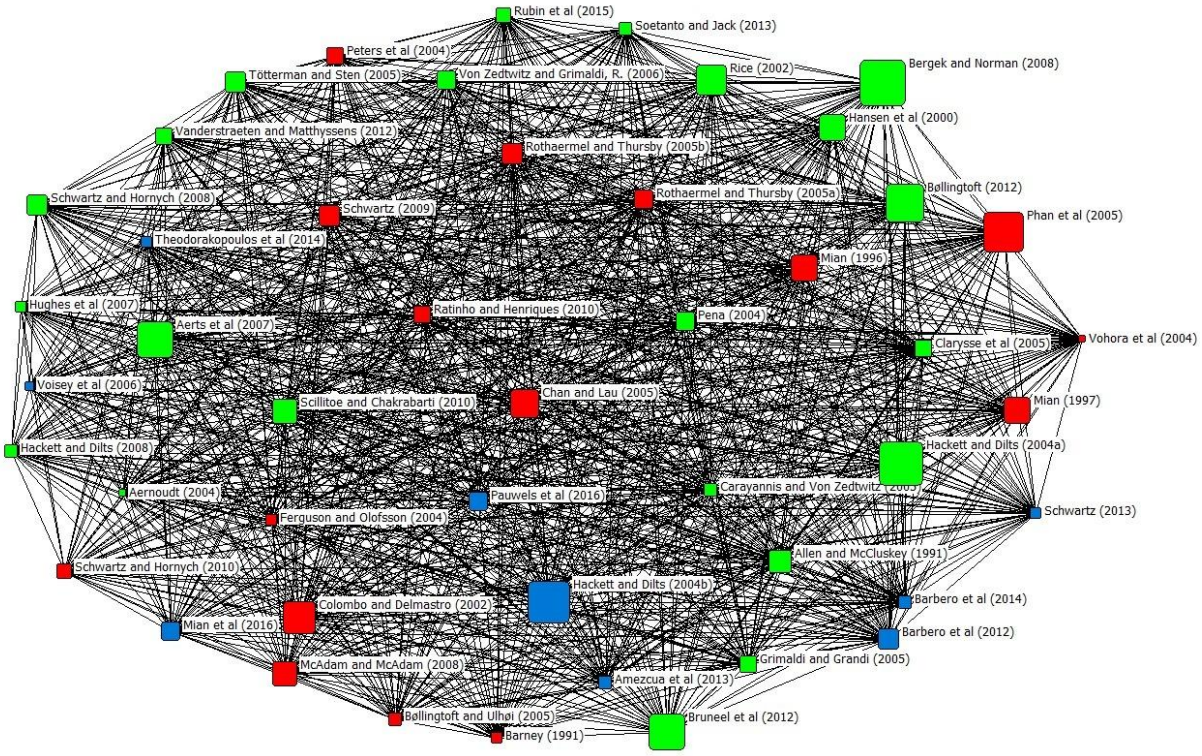

Figure 2.3. Co-citation network
Source: Ucinet

The larger the nodes in the network, the greater the absolute frequency of shared references established by an article, that is, the frequency with which such an article is co-cited. Cohesion and density measures complement the understanding of the relationship and overlap between the three factors in the relational network (Table 2.5). Density represents the extent to which a factor has common conceptual bases, and its maximum value is obtained when all possible links between references within the same factor are exhausted. It is a "within factor" indicator. Cohesion equates the density of a factor from its interconnection with other groups, indicating how much the concept the factor represents is independent. It is a "between factor" indicator (Wasserman & Faust, 1994).

Table 2.5. Co-citation network metrics

Factor	# of documents	Variance explained	Density	Cohesion	Centrality
1	16	27.64	1.00	1.00	Phan et al. (2005)
2	22	26.73	1.00	1.00	Bergek and Norman (2008) (*)
3	9	23.18	0.97	0.89	Barbero et al. (2012)

(*) Highest centrality across the network
Source: own elaboration

An overview of the network indicates an overlapping between the factors, mainly between factors 1 and 2. This can be confirmed by the cohesion, which is very high for Factors 1 and 2 and lower for factor 3. The first two factors deal with the antecedents of the incubator's performance, either through the identification of what is offered, between tangible and intangible assets, in the incubation period (Factor 1), as well as the importance of establishing relational networks, as support for the performance of the start-ups during the incubation period and after graduation, giving success to the business incubators (Factor 2).

It is worth noting that the study with the highest centrality, which has the highest frequency of co-citation, that is, establishing links with other articles, is the article that seeks to identify an incubator model that offers the best practices and establishes criteria for its evaluation with greater rigor (Bergek & Norrman, 2008). The need for more clarity in identifying the performance of science parks and business incubators and how incubator typology impacts results are discussed by Phan et al. (2005) and Barbero et al. (2012), higher centrality papers on factors 1 and 3. Centrality in networks means clusters formed around the most cited articles, giving these articles greater relevance. These studies address the need to characterize what is essential for the incubation process's success, given the fragmentation of the literature in this regard.

The first factor was named **"Determinants of incubator performance."** The studies of this group point to factors that impact the performance of incubators and are offered in the incubation process. In general, the studies of this group emphasize the role of business incubators in providing start-ups with conditions to overcome the liabilities of newness. These threats of novelty relate to a need for more formalized processes and reputation and legitimacy with suppliers, consumers, and other start-up owners. Incubators provide training in managerial issues, coaching, and counseling besides subsidized physical structures (Ferguson & Olofsson, 2004; Schwartz, 2009; Vohora et al., 2004; Schwartz & Hornich, 2010). Formalization, legitimacy, and shared infrastructure are referenced under the resource-based theory lenses by Rothaermel and Thrusby (2005a) and McAdam and McAdam (2008). According to the resource-based view, business incubator is described as an institution that possesses resources (tangibles

and intangibles), that can be complementary to the resources tenants possess and can share them with tenants without incurring substantial costs (Colombo & Delmastro, 2002, McAdam & McAdam, 2008; Mrkajic, 2017).

In the search for what influences incubators' performance, Chan and Lau (2005) and Mian (1997) propose a set of factors in a framework for assessing incubators. These frameworks from Chan and Lau (2005) and Mian (1997) pointed to enhancing formalization through consulting and counseling services, legitimacy by providing access to venture capital, and, further, providing sharing laboratory facilities and office equipment, among other resources.

Table 2.6 briefly describes each study in Factor 1, emphasizing what they point to as performance drivers, and, in the last column, offers a coded view of these drivers.

Table 2.6. Determinants of incubator performance – Factor 1 papers

Title/authors	**Performance drivers**	**Performance drivers – Coding**
Ferguson, R., and Olofsson, C. (2004). Science parks and the development of NTBFs—location, survival and growth. *The Journal of Technology Transfer, 29,* 5-17.	Science park's location; cooperation with universities; image benefits.	Linkage to universities brings formalization[2] of procedures through facilitating knowledge and operational routines transfer. Provision of material structure.
Rothaermel, F.T., and Thursby, M. (2005b). Incubator firm failure or graduation? The role of university linkages. *Research Policy, 34*(7), 1076-1090.	Incubators with university linkages reduces the likelihood of failure of their tenants.	Establishing connections with universities formalizes procedures by facilitating the transfer of knowledge and operational routines. Provision of material structure.
Rothaermel, F.T., and Thursby, M. (2005a). University–incubator firm knowledge flows: Assessing their impact on incubator firm performance. *Research Policy, 34*(3), 305-320.	University incubators should perform better due to knowledge flow. Tenants benefit through license or absorptive capacity.	Forming partnerships with universities formalizes procedures by enabling the systematic transfer of knowledge and operational practices. Provision of material structure.
Mian, S.A. (1996). Assessing value-added contributions of university technology business incubators to tenant firms. *Research Policy, 25*(3), 325-335.	University-based incubators provide conditions for the development of new tech-based firms through a combination of university-related inputs and other typical incubator services.	Linkage to universities enhances formalization of procedures by facilitating knowledge and operational routines transfer. Provision of material structure.

[2] Formalization relates to the notion that appropriate behavior is specified in writing, then refers to what it is asked to do (Dalton et al., 1980), such as managerial roles, processes routines, operations, and strategies (Sine et al., 2006).

Title / Authors	Performance drivers	Performance drivers - Coding
Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management, 17*(1), 99-120.	Incubators as provider of sustainable resources.	Resources that enhance competitiveness.
Mian, S.A. (1997). Assessing and managing the university technology business incubator: An integrative framework. *Journal of Business Venturing, 12*(4), 251-285.	Performance dimensions: (1) program sustainability and growth (networking and managerial intervention); (2) tenant firm's survival and growth; (3) contributions to the sponsoring university's mission; and (4) community related impacts.	Linkage to universities brings formalization of procedures through facilitating knowledge and operational routines transfer. Provision of material structure. Legitimacy[3] through access to collaborators, suppliers, and financial funds.
Chan, K.F., and Lau, T. (2005). Assessing technology incubator programs in the science park: The good, the bad and the ugly. *Technovation, 25*(10), 1215-1228.	Proposed a framework to assess technology incubators, with nine sets of criteria (advantages from pooling resources, sharing resources, consulting services, positive effect from the higher public image, networking advantages, clustering effect, geographic proximity, cost subsidies, and funding support).	Belonging to a science park brings advantages from the effects of networking, cost subsidies, and sharing physical structures. Formalization of procedures through mentoring, coaching, and consulting. Legitimacy through access to collaborators, suppliers, and financial funds.
Colombo, M.G., and Delmastro, M. (2002). How effective are technology incubators? Evidence from Italy. *Research Policy, 31*(7), 1103-1122-	Key factors for science parks include a lean and agile internal organization, and effective coordination of the services provided by third parties, with the emphasis being placed on the brokerage and gate-keeping function (selection criteria).	Belonging to a science park offers several advantages, including the benefits derived from networking, cost subsidies, and shared physical infrastructure. Additionally, the formalization of procedures through mentoring, coaching, and consulting provides support to members.
McAdam, M., and McAdam, R. (2008). High tech start-ups in University Science Park incubators: The relationship between the start-up's lifecycle progression and use of the incubator's resources. *Technovation, 28*(5), 277-290.	Science Park incubators provide a stock of resources through office facilities, a canteen, a car park, shared secretarial services, access to practical support such as telephone lines and Internet access, and other intangible resources such as structure and formalization. The perceived value of these resources changes along the start-up life cycle.	Linkage to universities brings formalization of procedures through facilitating knowledge and operational routines transfer. Provision of material structure. Formalization of procedures through mentoring, coaching, and consulting.

[3] Legitimacy is defined as the perception that a company can operate in its environment by conforming to a system of norms, beliefs, and definitions (Navis & Glynn, 2011). Legitimacy is a function of factors such as organizational structure, procedures, reputation, the form of communication, and experiences (Suchman, 1995).

Schwartz, M. (2009). Beyond incubation: An analysis of firm survival and exit dynamics in the post-graduation period. *The Journal of Technology Transfer, 34,* 403-421.	The main objective of a business incubator is the promotion of survivability and the positive development of its tenants. Therefore, survival may be one of the most critical indicators of incubator success. Though the adoption of survival rates as the sole indicator is insufficient to capture the success or performance of an incubator since these covers only one dimension of the incubation process.	Provision of material structure. Formalization of procedures through mentoring, coaching, and consulting.
Peters, L., Rice, M., and Sundararajan, M. (2004). The role of incubators in the entrepreneurial process. *The Journal of Technology Transfer, 29*(1), 83-91.	The success of incubators lies not only on the provision of infrastructure and personnel services, but rather a combination of both these factors with networking and coaching that help the entrepreneurial process and survival of the graduated start-ups.	Provision of material structure. Formalization of procedures through mentoring, coaching, and consulting. Legitimacy through access to collaborators, suppliers, and financial funds.
Ratinho, T., and Henriques, E. (2010). The role of science parks and business incubators in converging countries: Evidence from Portugal. *Technovation, 30*(4), 278-290.	University links and suitable management (management profile, services provided and innovative ideas) are determinants for incubator success.	Belonging to a science park brings advantages from the effects of networking, cost subsidies, and sharing physical structures.
Vohora, A., Wright, M., and Lockett, A. (2004). Critical junctures in the development of university high-tech spinout companies. *Research Policy, 33(*1), 147-175.	Start-ups face a deficiency in social capital, resource weaknesses, and inadequate internal capabilities which act together to impede the value creation process.	Linkage to universities facilitates the formalization of procedures by enabling the transfer of knowledge and operational routines. Additionally, universities provide material structures and support the formalization of procedures through mentoring, coaching, and consulting.
Schwartz, M., and Hornych, C. (2010). Cooperation patterns of incubator firms and the impact of incubator specialization: Empirical evidence from Germany. *Technovation, 30*(9-10), 485-495.	It is important to the effectiveness of the incubator that the network's informal ties are strong to evolve into more formalized connections, such as supplier-customer relationships, joint R&D agreements, technology exchange agreements, or joint distribution exploitation.	Provision of material structure. Formalization of procedures through mentoring, coaching, and consulting.

Source: own elaboration

In the second factor, named "**Business networks"**, the work with the highest factorial loading, that is, with greater identification with the factor, is Hughes, Ireland, and Morgan (2007), who discuss the importance of social capital brought during incubation. Bøllingtoft (2012), Hughes et al. (2007) and Hackett and Dilts (2008) emphasize the relevance of collaborative networks for the success of start-ups in facing the liabilities of newness and smallness. These liabilities refer to some resource deficits of young and new firms. To neutralize these threats, business incubators can provide shared office space, laboratory equipment, and administrative services (Bøllingtoft, 2012). Peña (2004) and Schwartz and Hornych (2008) discuss networks as good incubation practices in the Basque Country and in Central German, respectively.

Incubators add value in terms of networking with customers, collaborators, and potential investors, as during the incubation period the access to internal and external ties is facilitated by incubators (Aernoudt, 2004; von Zedtwitz & Grimaldi, 2006; Scillitoe & Chakrabarti, 2010; Bruneel et al., 2012; Hansen et al., 2000; Grimaldi & Grandi, 2005). Also, taking part in a network increases the potential of tenants learning, which is crucial for the survival of young and small firms, as well as taking advantage of environmental opportunities (Bergek & Norrman, 2008; Rubin et al., 2015; Soetano & Jack, 2013; Allen & McCluskey, 1991; Tötterman & Sten, 2005; Rice, 2002; Hackett & Dilts, 2004a) and, therefore, new firms select the location that best fits their needs and expectations (Vanderstraeten & Mattyssens, 2012). Some studies delve into the best practices to stimulate and potentialize the effectiveness of a network, through screening practices for tenant selection (Aerts et al., 2007), adopting a spin-out strategy for successful start-ups (Clarysse et al., 2005), and constructing global networks to optimize local start-ups (Carayannis & von Zedtwitz, 2005). Table 2.7 summarizes the focus of the papers on this factor.

Table 2.7 Business network – Factor 2 papers

Title/authors	**Focus**
Hughes, M, Ireland, R.D., Morgan, R.E. (2007). Stimulating dynamic value: Social capital and business incubation as a pathway to competitive success. *Long Range Planning*, 40(2),154-177.	Incubating firms choose, whether deliberately or otherwise, to behave in ways that enable them to seize network opportunities and make use of networked resources and knowledge
Soetanto, D.P., Jack, S.L. (2013). Business incubators and the networks of technology-based firms. *The Journal of Technology Transfer* 38,432-453.	Incubator firms use networks for resource acquisition. However, what it also shows clearly is that highly innovative firms build networks with other incubator firms and in doing so look to create a mutually supportive environment.
Allen, D.N., McCluskey, R. (1991). Structure, policy, services, and performance in the business incubator industry. *Entrepreneurship Theory and Practice, 15*(2), 61-77.	Well-managed incubators not only make growth more affordable, but they also help: set realistic company milestones through graduated rent structures, create a polished professional image, and accelerate the networking process.
Rubin, T.H., Aas, T.H., Stead, A. (2015). Knowledge flow in technological business incubators: evidence from Australia and Israel. *Technovation* 41,11-24.	Incubators' internal processes, in particular, the interrelationships through which the incubator stakeholders share knowledge. Collaboration between incubatees and incubator management also increase incubatees' financial knowledge and their likelihood of raising capital.
Vanderstraeten, J., Matthyssens, P. (2012). Service-based differentiation strategies for business incubators: Exploring external and internal alignment. *Technovation* 32(12), 656-670.	In specialized incubators, companies seek core business networking possibilities with other tenants, whereas Schwartz and Hornych (2008) conclude that a negative climate impedes internal networking in focused incubators.

Title/authors	Focus
Hackett, S.M., Dilts, D.M. (2008). Inside the black box of business incubation: Study B—scale assessment, model refinement, and incubation outcomes. *The Journal of Technology Transfer* 33, 439-471.	When an incubatee belongs to one incubator's network contacts, the incubatee maximizes the opportunity present in the incubation.
Von Zedtwitz, M., Grimaldi, R. (2006). Are service profiles incubator-specific? Results from an empirical investigation in Italy. *The Journal of Technology Transfer 31,* 459-468.	The core services of start-up incubators are networking services, both incubator internal as well as external with customers, collaborators, and potential investors.
Bøllingtoft, A. (2012). The bottom-up business incubator: Leverage to networking and cooperation practices in a self-generated, entrepreneurial-enabled environment. *Technovation 32*(5), 304-315.	Networks are seen as critical for the survival and growth of an entrepreneurial venture/small firm because they can provide access to information, advice and influence as well as resources held by others.
Peña, I. (2004). Business incubation centers and new firm growth in the Basque Country. *Small Business Economics 22*(3/4), 223.	Networking opportunities in and out of the incubator could improve the odds of venture success (i.e., access to venture capitalists, financial institutions, potential partners to form alliances, public services to support entry into foreign markets, etc.).
Scillitoe, J.L., Chakrabarti, A.K. (2010). The role of incubator interactions in assisting new ventures. *Technovation 30*(3), 155-167.	This study examines the role of counseling and networking interactions with incubator management on both beneficial business and technical assistance for new technology based firms.
Carayannis, E.G., Von Zedwitz, M. (2005). Architecting Glocal, real-virtual Incubation networks (G-RVins) as catalysts and accellerators of entre% preneurship in transioning and developing conomies. *Technovation 5*(95), 110.	Link entrepreneurs and micro-entrepreneurs with local, regional, and global networks of customers, suppliers and complementors and thus help not only bridge, but also leverage the diverse divides (digital, knowledge, cultural, socio-political, etc.).
Schwartz, M., Hornych, C. (2008). Specialization as strategy for business incubators: An assessment of the Central German Multimedia Center. *Technovation 28*(7), 436-449.	Point deficiencies in an specialized business incubator, especially regarding internal networking activities and promotion of linkages to universities.
Bruneel, J., Ratinho, T., Clarysse, B., Groen, A. (2012). The Evolution of Business Incubators: Comparing demand and supply of business incubation services across different incubator generations. *Technovation 32*(2), 110-121.	BIs extended their value proposition by adding business support services (characterizing the second generation) and access to networks (characterizing the third generation) to their offer.
Hansen, M.T., Chesbrough, H.W., Nohria, N., Sull, D.N. (2000). Networked incubators. *Harvard Business Review 78*(5), 74-84.	The best business incubators offer an extensive network of powerful business connections, enabling fledgling start-ups to beat their competitors to the market.
Tötterman, H., Sten, J. (2005). Start-ups: Business incubation and social capital. *International Small Business Journal 23*(5), 487-511.	Business incubators can support new firms in their development process by giving them credibility, but also by helping them to build promising support and business networks
Aernoudt, R. (2004). Incubators: tool for entrepreneurship? *Small Business Economics 23*(2),127-135.	The lack of entrepreneurship and the underdevelopment of seed financing and business angel networks are deficiencies discussed.
Aerts, K., Matthyssens, P., Vandenbempt, K. (2007). Critical role and screening practices of European business incubators. *Technovation 27*(5), 254-267.	Screening practices by European business incubators in 2003 compared with American incubators and discuuss a link between screening practices and performance, measured in terms of tenant failure, is established.

Title/authors	Focus
Rice, M.P. (2002). Co-production of business assistance in business incubators: an exploratory study. *Journal of Business Venturing 17*(2), 163-187.	This study explores the types of business assistance provided through incubation, the modes oincubation, and factors that affect the variability of impact.
Clarysse, B., Wright, M., Lockett, A., Van de Velde, E., Vohora, A. (2005). Spinning out new ventures: a typology of incubation strategies from European research institutions. *Journal of Business Venturing 20*(2), 183-216.	(i) What differences or similarities are there in the goals and objectives of the Research Institutions for creating new spinout ventures? (ii) What different incubation strategies are employed to achieve these goals in terms of the networks resources utilized and activities undertaken?
Grimaldi, R., Grandi, A. (2005). Business incubators and new venture creation: an assessment of incubating models. *Technovation 25*(2), 111-121.	The paper discusses the variety of incubating organizations driven by the evolution of companies' requirements and needs, which encourage incubators to differentiate the range of services that they offer.
Bergek, A., Norrman, C. (2008). Incubator best practice: A framework? *Technovation 28,* 20-28.	The authirs discuss a suggested framework to incubation model that includes three distinguishing model components: selection, business support and mediation.
Hackett, S.M., Dilts, D.M. (2004a). A systematic review of business incubation research. *The Journal of Technology Transfer 29*(1), 55-82.	Literature review on business incubators and business incubation. Focusing on the primary research orientations—i.e. studies centering on incubator development, incubator configurations, incubatee development, incubator-incubation impacts

Source: own elaboration

The third factor, **"New trends,"** has two literature reviews on critical factors and best practices to promote the performance of incubators (Theodorakopoulos et al., 2014) and technology business incubators (Mian et al., 2016). In addition, three studies point out the incubation process as a neutralizer of liabilities of newness (Hackett & Dilts 2004b; Voisey et al., 2006; Amezcua et al., 2013). Pauwels et al. (2016) bring aspects of accelerators and characterize them as a new model of incubators with greater dynamism and shorter incubation periods. There are two papers in this factor discussing archetypes of business incubators. This is a refined approach, since the authors argue that there should be a proper type of incubator that better fits with types of innovation and, therefore, delivers better performance (Barbero et al., 2012; Barbero et al., 2014). Finally, the paper from Schwartz (2013) points to the same performance between incubated and not incubated firms. Table 2.8 summarizes the focus of the papers on this factor.

Table 2.8 New trends – Factor 3 papers

Title/authors	Focus
Theodorakopoulos, N.K., Kakabadse, N., and McGowan, C. (2014). What matters in business incubation? A literature review and a suggestion for situated theorising. *Journal of Small Business and Enterprise Development, 21*(4), 602-622.	This article provides a critical assessment of the literature on business incubation effectiveness and submits a situated theoretical perspective on how business incubation management can provide an environment that supports the development of their tenants.
Amezcua, A.S., Grimes, M.G., Bradley, S.W., and Wiklund, J. (2013). Organizational sponsorship and founding environments: A contingency view on the survival of business-incubated firms, 1994–2007. *Academy of Management Journal, 56*(6), 1628-1654.	Sponsorship in its various forms results in a discernible positive effect on the performance of sponsored incubators, while policy makers have generally claimed that sponsorship helps firms to survive and grow.
Mian, S., Lamine, W., and Fayolle, A. (2016). Technology Business Incubation: An overview of the state of knowledge. *Technovation, 50-51*(April-May 2016), 1-12.	This article introduces the Technovation Special Issue on Technology Business Incubation and addresses several key questions about them.
Pauwels, C., Clarysse, B., Wright, M., and Van Hove, J. (2016). Understanding a new generation incubation model: The accelerator. *Technovation, 50-51*(April-May 2016), 13-24.	This article discusses differences between accelerators and other incubation models and theorizes that differences in the objectives of shareholders, supporting or financing the accelerator, will lead to differences in the way accelerators run their programs.
Schwartz, M. (2013). A control group study of incubators' impact to promote firm survival. *The Journal of Technology Transfer, 38,* 302-331.	The author argues that he does not observe that firms located in incubators have higher survival chances than comparable firms located outside incubator organizations.
Barbero, J.L., Casillas, J.C., Wright, M., and Ramos-Garcia, A. (2014). Do different types of incubators produce different types of innovations? *The Journal of Technology Transfer, 39,* 151-168.	This article focuses on the need to understand the match between types of innovation and incubator archetypes.
Hackett, S.M., and Dilts, D.M. (2004b). A real options-driven theory of business incubation. *The Journal of Technology Transfer, 29*(1), 41-54.	The complexity of the incubation process, while providing a parsimonious framework for describing it, and predicting and explaining incubation process outcomes.
Voisey, P., Gornall, L., Jones, P., and Thomas, B. (2006). The measurement of success in a business incubation project. *Journal of Small Business and Enterprise Development, 13*(3), 454-468.	The academic literature investigates whether business incubation works and invites them to decide if the result is of value or not. This article considers additional ways to measure the success of this type of project.
Barbero, J.L., Casillas, J.C., Ramos, A., and Guitar, S. (2012). Revisiting incubation performance: How incubator typology affects results. *Technological Forecasting and Social Change, 79*(5), 888-902.	This research concludes that not all incubators' archetypes perform equally but that there are significant differences in the performance of the different archetypes. Some types perform better in specific performance measures while others perform worse.

Source: own elaboration

Figure 2.4 and Table 2.9 report the main results in terms of trends and new approaches in the study of business incubator performance, that emerge from Factor 3. Figure 2.4 shows that the articles classified in Factor 3 are the most recent references used by 299 papers of the sample employed to conduct this bibliometric research (gray zone), reinforcing the focus on new approaches in business

incubation research as common characteristics among its nine papers. As can be noticed, the papers were published after 2012 (gray zone).

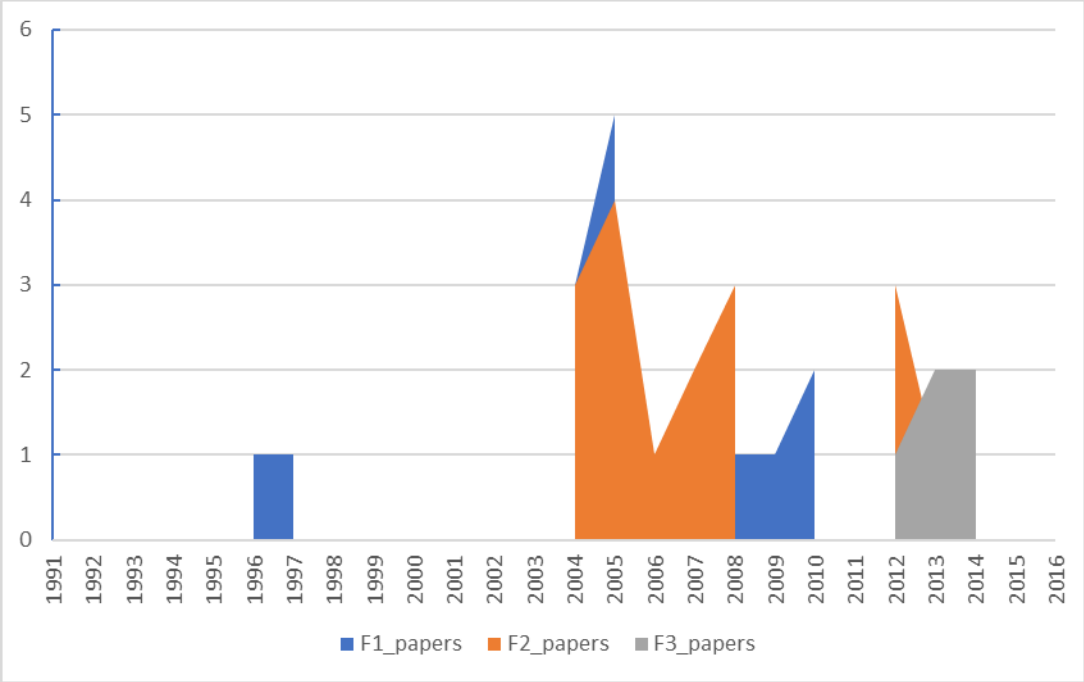

Figure 2.4 Publishing years of the articles belonging to the three factors
Source: MS Excel

From the research sample of 299 papers, 105 (35%) of them cited Factor 3 references 308 times. It is worth noting that the citations of these references in Factor 3, among the articles that make up the sample, are concentrated in the last five years (Table 2.9). This fact indicates that the works pertaining to this factor are used as references in the current academic production of studies on the performance of incubators. Therefore, they indicate a trend in current research on incubators' performance.

Table 2.9 Publishing years of papers citing Factor 3

Factor 3 - papers	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Theodorakopoulos_et_al_2014								1	3	5	2	8	5	4
Amezcua_et_al_2013								2	1	4	3	6	6	8
Mian_et_al_2016								1	1	4	10	8	8	10
Pauwels_et_al_2016								2	5	5	7	11	7	7
Schwartz_2013						1	0	3	7	5	4	4	1	3
Barbero_et_al_2014						1	0	0	1	11	4	9	2	3
Hackett_Dilts_2004b			1	1	0	0	2	1	5	7	3	1	3	5
Voisey_et_al_2006	1	0	0	0	0	0	0	4	1	7	4	2	3	4
Barbero_et_al_2012						2	0	5	3	7	9	10	4	10

Note: numbers in the cells are the citation frequency of the references in the left column.
Source: MS Excel

2.4.3 Co-word analysis

As a means to enlarge the understanding of Factor 3 to delve into research question 3 (what are the trends in incubation performance research?), we conducted a co-word analysis. This analysis gathers the words in the key-words field of a paper and counts the co-occurrence frequency employed by two or more authors. We used a sample of the 105 studies that cited this factor in their references from our primary research sample of 299 papers. Like co-citation analysis, they are grouped through a clustering process, (Figure 2.5, Table 2.10). Further, we characterized these groups by the similarities among the words of each one (Table 2.11). We obtained three groups called (1) performance, (2) incubation process, and (3) network, thus enabling us to identify the conceptual structure of the research field under investigation and the most critical trends in the literature on the performance of incubators (Cobo et al., 2011; van Eck & Waltman, 2019).

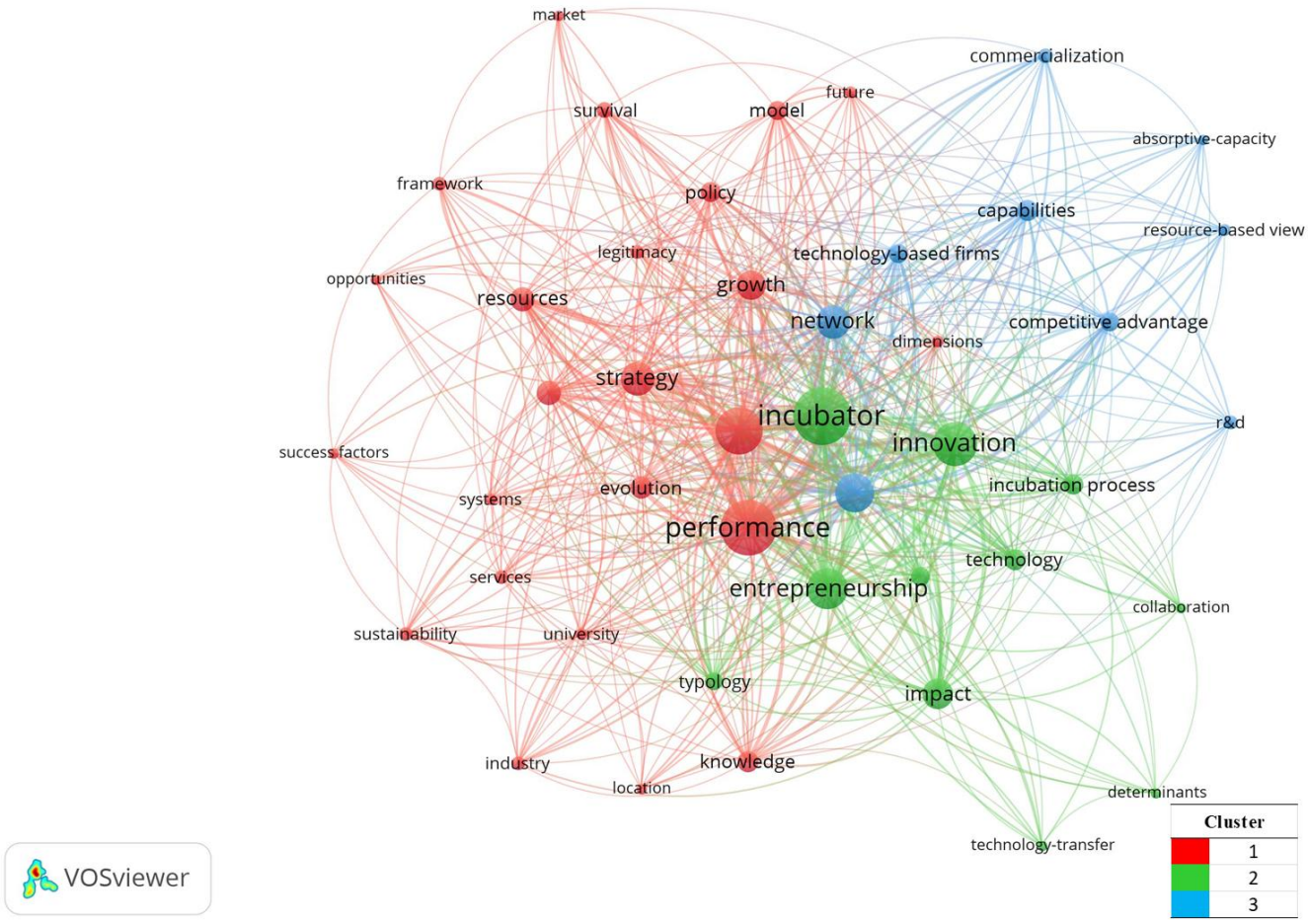

Figure 2.5 Co-word – Factor 3
Source: VOSViewer

Table 2.10. Keywords co-occurrence – Factor 3

Keyword	Occurrences	Cluster	Links
Performance	80	1	45
start-up	58	1	45
Strategy	29	1	38
Growth	23	1	36
entrepreneurial ecosystem	15	1	34
Resources	15	1	35
Evolution	13	1	29
Knowledge	12	1	25
Policy	11	1	27
Model	10	1	24
Incubator	88	2	45
Innovation	52	2	42
Entrepreneurship	45	2	44
Impact	24	2	32
Technology	12	2	28
incubation process	11	2	28
Management	10	2	27
science park	40	3	42
Network	29	3	38
Capabilities	12	3	30
competitive advantage	10	3	25
technology-based firms	10	3	27

Source: own elaboration

Table 2.11. Keywords clusters

Cluster	Similarities
1	Performance
2	Incubation process
3	Networks

Source: own elaboration

The results of the co-citation and keywords analyses need to be reconciled, considering the structural relationships between the two approaches. Figure 2.6 represents a conceptual framework proposed and brings an integration of our findings.

Through our bibliometric research, we show that the incubation process strengthens incubated companies as they provide conditions to neutralize threats to survival expected to new companies. These

threats, which are internal or external, refer to the weaknesses that new and small companies suffer and are known as the liability of newness (Amezcua et al., 2013; Stinchcombe, 1965) and liability of smallness (Aldrich & Auster, 1986; Schwartz, 1986; Schwartz, 2013). Business incubators' primary objective is to promote the survival and development of their tenant companies through the services offered during the incubation process. The literature on these processes that occur during incubation is fragmented, and through this study, we have divided these processes into three groups:

(1) Provision of physical structure, the most common service. These are assets shared with other tenants at a subsidized cost, such as offices and laboratory services.
(2) Formalization of processes and procedures, including mentoring, consultancy, and support for the company's operating activities.
(3) Legitimation and reputation through networking and access to potential suppliers and consumers.

The type of service that best suits each company depends on the balance between the skills and capabilities of the incubator, among the various incubation models and each company. The incubator's performance is related to the quality and intensity with which these services are offered and how companies absorb them to support their evolution after leaving the incubator. Therefore, the performance of an incubator is integrated with the company's survival and growth in terms of job creation and increased sales after the incubation process.

In this way, the performance of graduated companies is a determining factor for the performance of incubators, which, in turn, promotes the survival and growth of the incubator, expressed in high occupancy rates, reputation, and more significant support from its stakeholders. The co-citation and keywords co-occurrence analysis results need to be reconciled, considering the structural relationships between the two approaches. Figure 2.6 represents the integration of our results. Factor 1, our study focus, is supported by the structure of Factor 2 and Factor 3. The conceptual framework proposed (Figure 2.6) depicts the complexity of a fragmented body of literature. It seeks to bring together the main findings of this bibliometrics and suggest themes for a research agenda.

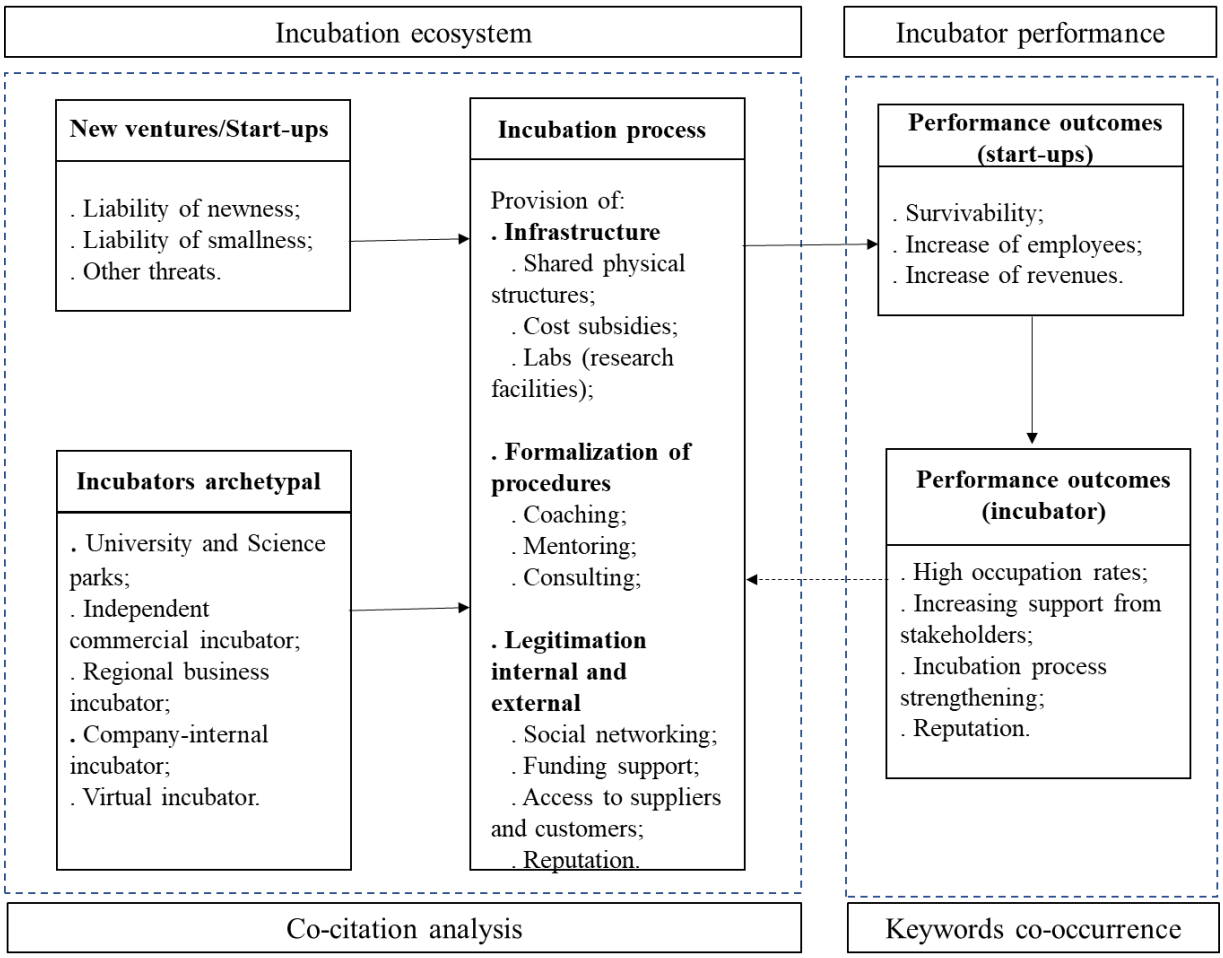

Figure 2.6 Conceptual Framework
Source: own elaboration

2.4.4 Incubators' performance: future research

Future research should address specific questions. The conceptual framework proposed in this study provides the basis for further empirical investigation. It opens up a debate about how business incubators should best support new ventures using assets concerning physical and structural support, formalization efforts, and establishing networks within suppliers, customers, and other stakeholders. We specifically delineate a future direction of research within incubators' performance through the lenses of performance drivers, incubation process, and relational network (see Table 2.12). These three research focuses emerged from keyword analysis as top research trends on incubators' performance.

Performance

Business incubators serve as catalysts for nurturing and accelerating the growth of start-up ventures. Various factors contribute to the effectiveness of these incubators in fostering start-ups'

performance. One critical aspect to consider is the alignment between the incubator archetype and the nature of the start-ups it supports (Barbero et al., 2014). Different incubator archetypes exist, each catering to distinct entrepreneurial needs. For instance, a technology-focused incubator might be better suited for technology-driven start-ups. In contrast, a social impact-focused incubator might benefit ventures with a social mission more. Assessing the match between the incubator archetype and the start-ups it supports is essential for optimizing outcomes and, thus, enhancing new ventures' survival and growth.

Developing a comprehensive scale to assess business incubator performance is paramount for evaluating its effectiveness. Messeghem et al. (2018) proposed a scale tailored for assessing the performance of for-profit business incubators. Adapting this scale for non-profit incubators requires careful consideration of their unique objectives and success metrics. Additionally, integrating elements from Hackett and Dilts (2008) performance construct could enhance the scale's applicability and comprehensiveness. This may involve incorporating measures of social impact, sustainability, and stakeholder satisfaction, aligning with the objectives of non-profit incubators.

Multistakeholder evaluation is crucial for gaining a comprehensive understanding of incubator performance (Rubin et al., 2015). In addition to input from entrepreneurs, incorporating perspectives from angel investors provides valuable insights into start-ups' investment readiness and growth potential. Furthermore, it is relevant to consider the perspectives of other stakeholders, such as government agencies, industry partners, and community members, to enhance a holistic assessment of business incubator performance (Schwartz & Hornych, 2008).

Contextual factors such as access to capital, talent pool, regulatory framework, and market dynamics shape the opportunities and challenges faced by incubated ventures and build networks with other incubator firms and, in doing so, forge the creation of a mutually supportive entrepreneurial environment (Soetanto & Jack, 2013). Incubators operating in vibrant entrepreneurial ecosystems will likely achieve higher success rates due to abundant resources, networking opportunities, and supportive infrastructure (Theodorakopoulos et al., 2014). In addition, the economic status of a country also plays a role in incubator performance (Ratinho & Henriques, 2010; Sydow, Cannatelli, Giudici, & Molteni, 2022). In economically developed regions, incubators may benefit from greater access to funding, expertise, and market opportunities, fostering a more conducive environment for start-up growth (Tsaplin & Pozdeeva, 2017). However, incubators in developing economies often need help with resource

constraints, infrastructure gaps, and market volatility, which can impact their effectiveness in supporting start-up ventures (Ratinho & Henriques, 2010).

Various benefits provided by the incubator must be considered in assessing the relative relevance driving incubator performance. While physical structure, process formalization, and legitimacy contribute to incubator effectiveness, their relative importance may vary depending on the context and stakeholder perspectives (Peters et al., 2004; Theodorakopoulos et al., 2014). Establishing a balanced approach to evaluating these factors can provide insights into the mechanisms driving incubator performance and guide efforts toward enhancing their impact on start-up success.

Incubation process

Central to achieving performance in business incubation is determining the fit between the incubator's business model, the type of new venture it seeks to nurture, and the context of the country in which it operates (Carayannis & von Zedtwitz, 2005). This assessment thoroughly evaluates the incubator's focus, target market, and resource availability, ensuring alignment with the local entrepreneurial ecosystem and economic conditions. This creates conditions to enhance the incubation process.

In addition, adapting incubation process assessment tools developed in specific contexts for broader applicability is also paramount. For instance, Binsawad et al.'s (2019) questionnaire, designed to assess the incubation process in Saudi Arabia, can be refined and adapted for Western incubators. This adaptation process involves reviewing constructs and items for relevance and applicability while considering cultural, institutional, and contextual differences, thus enhancing the tool's utility across diverse incubator settings.

A determining factor in the success of the incubation process is the governance models (Han, Su, Lyu, & Liu, 2022). Whether centralized structures led by government entities, decentralized models driven by private-sector actors, or hybrid arrangements involving public-private partnerships, the chosen governance model must align with the incubator's objectives, stakeholder dynamics, and regulatory environment (Han et al., 2022; Santos, 2022). This facilitates transparency, accountability, and strategic decision-making, fostering an environment conducive to start-up survival and growth and bringing effectiveness to the incubation process.

Strategic orientation is another critical consideration in optimizing the incubation process and its performance. Aligning strategic priorities with each incubator archetype's unique strengths and resources

enhances its ability to foster start-up success (Tondolo, Tondolo, Camargo, & Bitencourt, 2015). Whether focused on infrastructure provision, mentorship, access to funding, or industry-specific support, strategic orientations must be tailored to the incubator's focus, maximizing the incubation process's results (Peters at al., 2004).

The incubators' screening processes to identify potential start-up ventures and mitigate investment and resource allocation risks must be considered (Rubin, Aas, & Stead, 2015). Criteria for selection often includes market potential, team capabilities, and innovation novelty, aiming to maximize the success rate of supported ventures while minimizing failures. By employing robust screening processes, incubators enhance their performance in nurturing successful ventures and driving economic growth.

The institutional environment also significantly influences the success of the incubation process (Narayanan & Shin, 2019; Sydow et al., 2022). Regulatory frameworks, funding mechanisms, and support networks create an enabling environment for start-up growth and innovation. Favorable institutional environments characterized by supportive policies, access to financing, and robust innovation ecosystems facilitate incubator effectiveness and enhance the likelihood of start-up success.

Network

Entrepreneurial orientation, characterized by a proactive, innovative, and risk-taking approach, should incline incubators and start-ups toward engaging in networking endeavors (Wu et al., 2020). Through proactive outreach, innovative collaboration, and risk-taking initiatives, incubators foster networking opportunities to enhance knowledge sharing, resource access, and strategic partnerships among stakeholders, contributing to the business incubator's effectiveness.

Another issue related to contextual characteristics is that environmental dynamism can also influence the effectiveness of networking activities within business incubators (Wu et al., 2020). Environmental dynamism, characterized by the pace of change, uncertainty, and complexity in the external environment, can either facilitate or hinder networking efforts (Wu, Wang, Wu, 2021). In dynamic environments where market trends evolve rapidly, networking becomes essential for staying abreast of emerging opportunities, accessing timely information, and adapting strategies to changing scenarios (Soetanto & Jack, 2013). Conversely, networking may be less urgent in more stable environments but remains valuable for maintaining connections and exploring potential synergies.

The impact of networking efforts, whether internal or external, extends beyond the incubation period and can influence graduated ventures' performance (Soetanto & Jack, 2013). Internally,

networking within the incubator ecosystem fosters collaboration, knowledge exchange, and mutual support among start-ups, mentors, and incubator staff. This collaborative environment can contribute to develop a robust entrepreneurial culture, sharing best practices and leveraging collective resources for mutual benefit. Externally, networking with industry partners, investors, and other stakeholders can promote market opportunities, funding sources, and strategic alliances that drive growth and sustainability after graduation (Soetanto & Jack, 2016).

University linkages represent a significant networking facet within the business incubation ecosystem, particularly in academic-affiliated incubators (Soetanto & Jack, 2016). The question arises: Do these linkages promote profitable firms through technology development or serve as inhibiting factors? While university linkages can offer valuable resources, expertise, and access to research and development facilities, their impact on firm performance may vary. Collaborative research and technology transfer initiatives facilitated by university linkages can enhance the innovative capacity of start-ups, leading to the development of new technologies and competitive advantages. However, challenges such as intellectual property rights, bureaucratic hurdles, and conflicting priorities may impede the commercialization of research outcomes and hinder firm performance. Therefore, while university linkages offer significant potential for technology development, their effectiveness in promoting profitability depends on the alignment of incentives, effective collaboration frameworks, and proactive management of intellectual property issues. Table 2.12 summarizes the above points into a research agenda.

Table 2.12. Roadmap for Future Research

Performance
* Which incubator archetype has a better match with hatching profitable start-ups?
* How to consider a multistakeholder evaluation of performance, including inputs from angel investors and entrepreneurs?
* Does the country's economic status affect the incubator's performance?
Incubation process
* Is there an "optimal" fit for the incubator business model, innovation type, and country?
* How can Binsawad's *et al*. (2019) questionary for assessing incubation process efficacy developed in Saudi Arabia be adapted for western incubators?
* Which governance model most effectively supports a well-succeeded incubator?
* Which strategic orientation best fits each incubator archetype to result in better performance?
* Do incubators seek performance through screening processes?
* How does the institutional environment determine incubation process success?
Network
* Does entrepreneurial orientation promote networking activities?
* Does environmental dynamism impact business incubator networking efforts?

* How do networking efforts, internal or external, impact performance after graduation?
* Do university linkages promote profitable firms through technology development, or is it an inhibiting factor?

Source: own elaboration

2.5 Discussion, conclusions, and limitations

We used bibliometric techniques to understand the theoretical foundations of business incubators' performance research and to identify factors influencing their performance. The combined co-citation and keywords co-occurrence analyses led to a broader field mapping. The techniques employed allowed to conduct a literature review without sample bias. Above all, it showed, on one side, how fragmented this research is, with many suggestions of what factors drive incubators´ performance. On the other hand, this bibliometric research allowed to identify three main groups of themes that underly and are the focus of incubators performance research, namely, (1) material structure, (2) formalization of routines and roles, and (3) legitimacy by networking with collaborators, suppliers, and other stakeholders.

The co-citation analysis defined three branches of the theoretical basis of the literature on incubators´ performance. The exploratory factor analysis used in co-citation clustered the sample of 299 documents in three research themes: determinants of performance, business networks, and new trends. The first two groups deal with the antecedents of performance. These antecedents are tangible and intangible assets provided by the incubator as a protective shield to the tenants or, in other words, as a bridge over troubled waters arising from the initial stages of market entry. These antecedents could be aggregated in three focuses: offer of shared physical structure, learning practices leading to formalizing roles and routines, networking with suppliers, customers, and financial agents, and, thus, gaining reputation and legitimacy in the competitive environment.

These three research foci impact on the results of the incubation process and determine, on a grand scale, the success of the new firms during and after incubation. This is another point to make clear. As business incubators aim to make the development of new firms easier, their success is related to their ex-tenant's performance. Newly founded firms suffer from the liabilities of newness and smallness, characterized by the lack of resources needed to survive and grow (Stinchcombe 1965; Aldrich and Auster 1986) and, during the incubation process, they are provided with these resources through the physical structure, like shared office space and equipment, coaching, training, and establishing collaborative networks.

Co-citation Factor 2 brings the crucial role of networking ties to start-up survival. There is an overlap between Factors 1 and 2, as several Factor 1 studies are contextualized in science parks,

underlying a network activity among the members and, thus, contributing to achieving performance. Legitimacy, a driver to success in Factor 1, is a consequence of networking ties, as it points to gaining reputation and identification in the business environment. This fact can also be observed in the relational network (Figure 2.3), in which references belonging to the two factors are mixed.

Factor 3 points to research trends. Identifying the best match between the incubator archetype and the type of start-up innovation is an essential issue regarding assessing an incubator and is a trending topic in research. What is discussed is if there are differences in performance among the benefits incubators provide. Incubator archetypes are also subjected to specific performance measures regarding their objectives, such as producing technology or collaborating with academic research. However, graduated firms from the incubation process seek to survive and achieve success since the primary measure of incubators´ performance generally depends on the success of their ex-tenants. With all these points together, we proposed a framework for predicting and explaining incubation outcomes that could help an entrepreneur choose an incubator to hatch a new venture (Figure 2.6).

As a means to enlarge the understanding of Factor 3 to delve into our research question about identifying the trends in incubation process research, we conducted a co-word analysis. The keyword co-occurrence confirmed that research on the performance of business incubators has three fronts: (1) studies on performance measures and influencing factors; (2) the incubation process itself, with an emphasis on fostering entrepreneurship and innovation and technological development and (3) the establishment of networks that allow incubated companies to have access to stakeholders and collaborative networks that contribute to the development of tenants' absorptive capacity and the consequent strengthening of their activity. In this regard, it is essential to note that networking generates reputation and legitimizes the firm in the business environment. The co-occurrence network of keywords shows an overlap of the Performance factor with the two others, Incubation Process and Networks, identifying that the focus on performance underlies research related to the incubation process and networking.

This study contributes in several ways. First, to academics, by summarizing a fragmented body of literature and extracting and consolidating issues regarding business incubator performance. Further, we propose an agenda for future research, attempting to go deeper into this investigation's results. Second, to entrepreneurs and start-up's managerial body, by identifying aspects that should be used to assess and choose an incubator.

Bibliometrics enables the identification of patterns and relationships, encompassing the whole range of a body of literature (Duran-Sanchez, Alvarez Garcia, Del Río-Rama, & Ratten, 2019). Then,

our conclusions were based on bibliometrics' logic and techniques to determine if there were a possible set of measures and factors to characterize the antecedents of business incubator performance, independently of incubator archetype and context. Our findings were derived from a method that allows the analysis of a broad scope of the literature, showing evidence of relationships that might not be evoked in strictly qualitative analysis. However, this work has limitations, which are inherent to the method, its temporal nature and sample collection. Therefore, it is an opportunity to explore relations of business incubators and incubation process with other emerging approaches to entrepreneurship, as suggested by Mrkajic (2017), or Theodorakopoulos et al (2014).

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Chapter 3 – The role of different types of complementary assets and the entrepreneurial environment on the performance of Brazilian business incubators[4]

ABSTRACT

Business incubators aim to promote their tenant companies' survivability and development. Thus, the success of incubators is linked to the survival of new companies during and after the incubation period. By focusing on the complementary assets provided during incubation, this study aims to assess incubators' factors of success using the survivability of graduated firms. We used a sample of graduated ventures for three years from 109 Brazilian business incubators. Our findings reveal that complementary assets have played a key role in their survival, mainly the specialized complementary assets such as those shaping legitimacy and reputation. Furthermore, these effects are influenced by the entrepreneurial intensity of the incubator's environment. These results contribute by providing insights for scholars due to enhancing the role of complementary assets for managing business incubators and start-ups, as well as for entrepreneurship policymakers at management levels.

Keywords: business incubator; complementary asset; legitimacy; formalization; infrastructure; entrepreneurial environment.

3.1 Introduction

Newly founded firms have a high degree of vulnerability in the face of competitive scenario uncertainties and limited access to necessary resources for their evolution and insertion in social networks (Amezcua, Grimes, Bradley, & Wiklund, 2013; Amezcua, Ratinho, Plummer, & Jayamohan, 2020; Stinchcombe, 1965), such as the access to funding sources and favorable institutional contexts, e.g., government policies and programs, access to professional services and skilled labor (Delic, Alpeza, & Peterka, 2012; Hansen, Chesbrough, Nohria, & Sull, 2000).

Business incubators have become a worldwide phenomenon. In fact, the creation of new companies is at the heart of economic growth (Ratinho, 2011). In this context, business incubation has been used as an entrepreneurial policy for economic and social development with the underlying logic that new companies increase innovation, job creation, and social cohesion (McAdam & Marlow, 2007;

[4] Submitted to the 2024 Academy of Management Annual Meeting and to the EURAM 2024 Annual Conference / Submitted to the Technological Forecasting and Social Change – Scopus Q1 / JCR Journal Impact Factor: 12.9.

Dee, Livesey, Gill, & Minshall, 2011; Theodorakopoulos, Kakabadse, & McGowan, 2014), as business incubators' primary objective is to promote their tenant companies' survivability and growth (McAdam & Marlow, 2007; Theodorakopoulos et al., 2014; Amezcua et al., 2020).

By providing means to strengthen new companies in the initial period of their activity in a controlled environment, incubators offer tenants a combination of supportive complementary assets that contribute to mitigate survival risks and lead tenants to operational development. (Dee *et al.,* 2011; Dee, Gill, Lacher, Livesey, & Minshall, 2013; Tötterman & Sten, 2005). Complementary assets are supporting resources, capabilities, or skills, physical, human, or organizational, which can be classified as physical infrastructure offered, support on formalization processes, and support on the search for legitimacy allowing firms to gain benefits, usually financial, associated with a strategy, technology, or innovation (Reyes-Rodríguez & Ulhøi, 2022; Taylor & Helfat, 2009; Teece, 1986). In addition, business incubators boost entrepreneurs' confidence by creating conditions for integration with resource providers (e.g., financiers and suppliers) and relationship networks (Rothaermel & Thursby, 2005), making it possible for graduated firms to carry characteristics that strengthen them after leaving the incubators, leading them to achieve performance and, consequently, to the success of the incubator, once it has fulfilled its primary objective.

Previous studies state that an environment with the munificence of resources and high organizational density favors entrepreneurial activities and have suggested an influence of the environment in which the incubator is located on its performance (Baraldi & Havenvid, 2016; Vanderstraeten, van Witteloostuijn, Matthyssens, & Andreassi, 2016; Amezcua et al., 2020). Researchers have examined incubators' factors of success, such as, geographic proximity between incubators (Hou, Hong, & Yang, 2022), government support (Han, Su, Lyu, & Liu, 2022; Ünlü, Temel, & Miller, 2022), and innovation generation in corporate incubators (Kruft & Koch, 2019), but in a fragmented way. Although some studies evaluate the determining factors for the performance of graduated firms (Guerrero, Urbano, Cunningham, & Gajón, 2018; Lasrado, Sivo, Ford, O´Neal, & Garibay, 2016; M'Chirgui, Lamine, Mian, & Fayolle, 2018), and several assessment models have been suggested (Azadnia, Sthephens, Ghadimi, & Onofrei, 2022; Bala Subrahmanya, Satyanarayana, & Chandrashekar, 2019; Nicholls-Nixon & Valliere, 2020; Ojaghi, Mohammadi, & Yazdani., 2019), there is a lack of research exploring the performance of incubators through the success of ex-tenants, taking into account the results arising from the incubation process (Dee et al*.,* 2011; Theodorakopoulos et al., 2014; M'Chirgui et al*.,* 2018). On other hand, the literature usually neglected the inherent influence of the institutional environment on incubator dynamics (Mrkajic, 2017).

As defended in the literature, the success of incubators is linked to the survival of new firms during and after the incubation process period as, typically, the mortality rate of new ventures is higher than among established companies (Aernoudt, 2004; Schwartz, 2009; Tamásy, 2007). By considering the benefits of the incubation process as complementary assets transferred to the business-incubated firms (Bruneel et al., 2012; Fukugawa, 2018; Nicholls-Nixon et al., 2022; Khodaei et al., 2022), the success of former tenants is associated with what they received in the incubation and thereby the incubators' performance is evaluated. Departing from this axiom, this study fills the gap identified in incubator success measures. Specifically, the primary objective of this work is to investigate the role of complementary assets in the success of business incubators through the performance of graduated firms nurtured with these complementary assets during the incubation process, using the entrepreneurial environment as a moderating factor that can enhance the performance of graduated companies and, therefore, the success of incubators.

This study contributes to the literature by highlighting factors impacting business incubation's success. Further, we uncover the complementary assets' role and the entrepreneurial environment's moderator role in business incubators' performance. Previous studies showed the positive impact of the environment on entrepreneurship (Amezcua et al., 2020; Autio, Kenney, Mustar, Siegel, & Wright, 2014; Zahra, Wright, & Abdelgawad, 2014). Therefore, we brought to our research the question of the moderation effect of the entrepreneurial environment. This is another contribution to theory and practice. Our research also contributes to supporting founders and managers of small businesses and incubators by providing evidence of which attributes "make the difference" in the incubation process.

The archetype of the incubator and the services provided in the incubation process could influence its performance since it determines the blend of support available to tenants (Theodoraki, Messeghem, & Audretsch, 2022). The study was conducted using business incubators that are members of the Brazilian Association of Entities for the Promotion of Innovative Ventures (ANPROTEC) and with graduated firms from these incubators.

Following this introduction, Section 2 reviews the business incubation literature emphasizing measures of incubator performance and the relationship with complementary assets and the entrepreneurial context, followed by proposed hypotheses. Section 3 describes the study's methodological framework, data analysis, and employed methodology. Section 4 brings the results of hypothesis tests through regression analysis. Finally, Section 5 presents conclusions, limitations, and research opportunities.

3.2 Theory review and hypotheses

3.2.1 Business incubators

There are several definitions of business incubators from both academic and non-academic literature. However, most studies agree that incubation refers to a structured and supportive program designed to nurture and assist early-stage businesses in their development and growth (Theodorakopoulos et al., 2014). Business incubation takes place along three main dimensions: (i) infrastructure – this involves office facilities rented in favorable conditions to tenants, and laboratory and manufacturing equipment; (ii) business support, namely a pool of shared support services, professional business support or advice; and (iii) access to internal/external network provision to start-up firms (Bergek & Norrman, 2008; Hackett & Dilts, 2004). Business incubators, as service providers, also provide tenant firms the access to counseling and business assistance with experts in areas including marketing, financial and legal issues and facilitate integration into social networks with suppliers, potential customers, and other firms (Azadnia et al., 2022; Hacket & Dilts, 2004; Mas-Verdú, Ribeiro-Soriano, & Roig-Tierno, 2015). The main goal of business incubation is to increase the chances of success for new ventures, by offering a supportive environment that addresses their specific needs and challenges (Torun, Peconick, Sobreiro, Kimura, & Pique, 2018). Previous studies identify the incubation role as an entrepreneurship tool for economic and social development, once it enables start-ups to be successful and would enhance innovation, job creation, and social evolution (UKBI, 2017; Dee et al., 2011; Theodorakopoulos et al., 2014).

During incubation, tenant firms are provided with low-cost specialized services and infrastructure, such as office spaces, shared equipment and laboratories, and administrative and logistic services, creating opportunities for networking and access to venture capital (Apa, Grandinetti, & Sedita, 2017; Bergek & Norrman, 2008; Hackett & Dilts, 2004). By providing access to or enabling the acquisition of some assets, business incubators offer a valuable service to incubated firms. In other words, they hatch their performance, compensating for threats related to age and, generally, the size typically attributed to newly founded firms (Aldrich & Auster, 1986; Ferguson & Olofsson, 2004; Stinchcombe, 1965). These assets can be classified as complementary assets, which are resources tangible or not, and physical and human capabilities or skills inherent to the firm. (Reyes-Rodríguez & Ulhøi, 2022; Teece, 1986).

Incubators can be considered policy-driven organizations to respond to the “liability of newness.” The idea of “liability of newness” is often used to explain that young and newly founded firms are more

likely to fail in their very first years of life because they are unable to overcome resource gaps needed to survive (Apa et al., 2017; Ferguson & Olofsson, 2004; Stinchcombe, 1965). Similar arguments can be found in the "liability of smallness propositions". Instead of focusing on age-dependency and firms' failure risks, the liability of smallness focuses on the impact of size on firms' death risks (Aldrich & Auster, 1986) as a complementary explanation for failure risk with age (Apa et al., 2017; Geroski, 1995).

The basic argument for both liabilities of newness and smallness is that small and newly founded firms face a discrepancy between critical resources necessary for their viability and their available resource base, factors that, directly and indirectly, affect the likelihood of survival (Breivik-Meyer, Arntzen-Nordqvist, & Alsos, 2019). These "liabilities" point out that new firms do not have access to information and business relationships with potential customers and suppliers or yet, they lack the expertise required to complete new product and process development. Either, they do not have access to expensive equipment or access to funding agents and skilled employees. Additionally, new firms must learn specific roles and tasks and develop routines involving considerable resource expenditure (Aldrich & Auster, 1986; Apa et al., 2017; Breivik-Meyer et al., 2019; Stinchcombe, 1965). In fact, several studies already showed that new firms have little organizational legitimacy which limits their opportunities for resource acquisition and propensity survive (Freeman, Carrol, & Hannan, 1983; Hannan & Freeman, 1984). Thus, start-ups rarely have a strong reputation and need to gain legitimacy in the supply chain, so a challenge for young companies is to show that they are reliable and credible in their environment, being these goals made more viable as a result of incubation (Apa et al., 2017; Breivik-Meyer et al., 2019).

The attributes the incubation provides to contribute to its tenants' success can be classified as internal and external. Internal factors are associated with the entrepreneur's human capital, lack of experience in exploring and developing resources and routines, such as the management system, production processes, and selection of a good team (Breivik-Meyer et al., 2019; Liow & Wong, 2021). The lack of formalization of processes and planning and monitoring systems, leading to increased costs and loss of competitiveness is also included here, as well as the structure of the new company that needs to consume resources to adjust and adapt to the operation (Breivik-Meyer et al., 2019). External factors are related to problems of legitimacy, relationship, and cooperation with stakeholders, associated with the pressures from the environment and lack of institutional support to which the new firm is subjected, expressed through the scarcity of credit, lack of perceived legitimacy by suppliers and consumers and entry barriers to the market (Breivik-Meyer et al., 2019). These aspects are linked to the trust needed to form ties with other stakeholders like suppliers, customers, or, on a larger scale, government agencies (Apa et al., 2017).

The main characteristics associated with these liabilities, as well as the services provided during the incubation process that mitigate the threats of being young and small, enhancing the survival likelihood of the incubatees, are shown in Table 3.1.

Table 3.1. Liabilities of newness/smallness and complementary assets

Threats related to liability of newness/smallness	Services provided during incubation	Complementary asset archetype[5]	Complementary asset provided[6]
»Workers (founders and employees) do not know their role (Apa *et al*., 2017).	Human resources coaching (Breivik-Meyer *et al*., 2019; Liow & Wong, 2021).	specialized	formalization
»Knowledge of organizational routines are underdeveloped or only tacit (Apa *et al*., 2017; Breivik-Meyer *et al*., 2019; Sedita *et al*., 2018).	Support to formalize procedures (Liow & Wong, 2021; Nicholls-Nixon *et al*., 2022).	specialized	formalization
»Lack of social ties with stakeholders (Apa *et al*., 2017; Breivik-Meyer *et al*., 2019; Ramírez-Alesón & Fernández-Olmos, 2018).	Inclusion in businesses networks (Nicholls-Nixon & Valliere, 2021).	specialized	legitimation
»Lack of trust along the value chain (Breivik-Meyer *et al*., 2019).	Support to formalize procedures (Breivik-Meyer *et al.*, 2019; Chan & Lau, 2005).	specialized	formalization
»Weak customer-producer ties (Fukugawa, 2018; Liow & Wong, 2021).	Promotes access to suppliers and customers (Apa *et al*., 2017; Sedita *et al*., 2018).	specialized	legitimation
»Lack of legitimacy inhibits access to resources from the environment (Apa *et al*., 2017; Nicholls-Nixon *et al*., 2022).	Proximity to other companies enables insertion in the business environment (Liow & Wong, 2021).	specialized	legitimation
»Lack of financial support (Breivik-Meyer *et al*., 2019).	Enables access to investors (Breivik-Meyer *et al*., 2019).	specialized	legitimation
»Difficulty in attracting skilled workers (Breivik-Meyer *et al*., 2019).	Proximity to other companies enables insertion in the business environment (Nicholls-Nixon *et al*., 2022).	specialized	legitimation
»Resource constraint to get offices and operational infrastructure (Apa *et al*., 2017; Sedita *et al*., 2018).	Access to subsidized cost infrastructure (Apa *et al*., 2017; Sedita *et al*., 2018).	generic	infrastructure
»Resource constraint to get laboratory facilities (Ramírez-Alesón & Fernández-Olmos, 2018).	Access to subsidized cost infrastructure (Ramírez-Alesón & Fernández-Olmos, 2018).	generic	infrastructure

[5] See Section 3.2.3
[6] See Section 3.2.3

3.2.2 Measures of business incubator performance

Business incubators are promoted as tools to economic development, and they have been vastly studied to date (Mrkajic, 2017). More recently, incubators are central structures for supporting the entrepreneurial environment, through the promotion and supporting entrepreneurs to leverage their business opportunities (Clarysse, Wright, Bruneel, & Mahajan, 2014; Goswami, Mitchell, & Bhagavatula, 2018; Klofsten, Lundmark, Wennberg, & Bank, 2020; Pauwels, Clarysse, Wright, & van Hove, 2016; Ratinho, 2011; Rubin, Aas, & Stead, 2015; van Weele, van Rijnsoever, Eveleens, Steinz, van Stijn, & Groen, 2018) by building a bridge between their tenants and the external environment (Bergek & Norrman, 2008). Hence, one of the business incubation's primary objectives is promoting survivability and the positive development of their tenant firms (Hannon, 2005; McAdam & Marlow, 2007).

Accordingly, the most straightforward success measure considers the frequency of incubatees graduating from the incubator and surviving with increasing performance. However, academics have delved into determining a set of indicators to "illuminate the inner workings of the black box of business incubation" (Hackett & Dilts, 2004; Hackett & Dilts, 2008, p.440). Indeed, in literature, incubator success has been defined in several ways. Despite the existence of research on the subject, there is no consensus on the definition of indicators that best express the success of the incubators (Dee et al., 2011; Theodorakopoulos et al., 2014; UKBI, 2012).

Most researchers use business-incubated firms' survival and growth as performance indicators of incubation success (Aerts, Matthyssens, & Vandenbempt, 2007; Chan & Lau, 2005; Rathore & Agrawal, 2021; Wu, Wang, & Tsai, 2020), which are trivial indicators due to the economic role of new firms for the creation of jobs and income. Following the social and economic path, studies have devised several approaches concerning innovativeness and technology creation. Binsawad, Sohaib, and Hawryskiewycz (2019) indicate knowledge and innovation-sharing practices or registered patents (Wang, He, Xia, Sarpong, Xiong, & Maas, 2020) as measures of incubation success, as they promote regional development. Some authors point out that a successful incubation ends with an initial public offering (IPO) or a significant acquisition or merger (Avnimelech, Schwartz, & Bar-El, 2007; Gimmon & Levie, 2021). Drawing on a set of indicators, Messeghem, Bakkali, Sammut, and Swalhi (2018) proposed an adapted balanced scorecard (Kaplan & Norton, 2001) for social incubators and business incubators (Shehada, El Talla, Al Shobaki, & Abu-Naser, 2020).

Incubator scholars have used stakeholder theory, as incubators are part of a broader entrepreneurial ecosystem. There are various networks of interests involved, and it is of interest that the incubation process creates value for stakeholders (Nicholls-Nixon & Valliere, 2020). Some authors adopted a broad view of stakeholders, considering citizens and policymakers (McAdam & Keogh, 2006; Santos, 2022) or a narrower viewpoint, considering only the main stakeholders (Liow & Wong, 2021; Ratinho & Henriques, 2010).

In addition, works focused on what services, their quality and intensity, tenants are enabled, like infrastructure of office space and laboratories, shared logistic and administrative facilities, business support, and networking promotion (Apa et al., 2017; Azadnia et al., 2022; Breivik-Meyer et al., 2019; Sedita, Apa, Bassetti, & Grandinetti, 2018). Although a myriad of studies points out several criteria to measure the performance of an incubator, the literature remains fragmented and inconclusive, and incubator performance outcomes remain something of a "black box" (Wu, Wang, & Tsai, 2020).

3.2.3 Complementary assets and incubation process

Complementary assets are supporting resources, capabilities, or skills, physical, human, or organizational, that allow firms to gain benefits, usually financial, associated with a strategy, technology, or innovation (Reyes-Rodríguez & Ulhøi, 2022; Taylor & Helfat, 2009; Teece, 1986). Complementary assets are necessary when firms attempt to implement something new at any point of the value chain, from a new product or a new process up to its entry into the market (Sköld, Freij, & Frishammar, 2020; Narasimhan, Swink, & Viswanathan, 2010). Complementary assets can be generic, specialized, or co-specialized (Teece, 1986; Teece, 2006). Generic assets need not be adapted and can be obtained in the market or quickly built internally.

These assets are not considered strategically sustainable (Barney, 1991), as competitors easily imitate them, and their value is limited (Arora & Ceccagnoli, 2006). The opposite occurs with specialized and co-specialized complementary assets, which generally require a long development and resource expenditure and are difficult to replicate (Teece, 1986; Teece, Pisano, & Shuen, 1997). They are tailored exclusively to a specific firm to develop and enhance competitiveness (Sköld et al., 2020). By their nature, these assets are difficult to imitate once they result from specifically targeted interactions (Reyes-Rodríguez & Ulhøi, 2022). Therefore, specialized, or co-specialized complementary assets are unique, valuable, and difficult to imitate resources, constituting sustainable competitive advantages (Barney, 1991; Chiu, Lai, Lee, Liaw, 2008; Pongeluppe, 2022).

The literature on complementary assets includes, for instance, as generic complementary assets, office infrastructure, like parking lots, working spaces, office reception facilities, and manufacturing spaces (Carayannis & von Zedtwitz, 2005; Soetanto & Jack, 2013; Soetanto & Klofsten, 2021), and as specialized complementary assets, marketing and distribution networks, marketing and sales capabilities (Rothaermel & Hill, 2005) and mentoring, after-sales servicing, (Paradkar, Knight, & Hansen, 2015), workforce organization and training (Bresnahan, Brynjolfsson, & Hitt, 2002), and brand value, reputation, customer and suppliers networks, and specialized technology (Bresnahan et al., 2002; Helfat & Lieberman, 2002; Paradkar et al., 2015; Stieglitz & Heine, 2007).

Specialized complementary assets are only sometimes available to small firms, especially to new ones, resulting in three problems. First, nascent firms typically need more financial resources to acquire or form complementary assets that demand much capital (Nicholls-Nixon et al., 2022). Initial resources, such as involvement in the supply chain (Schwartz, 2013; Stinchcombe, 1965), the commitment of the team (Apa et al., 2017; Chorev & Anderson, 2006), and heterogeneity in the competencies and skills of the management team (Aspelund, Berg-Utby, & Skjevdal, 2005) can inhibit the chances of a new firm's survival and growth. Second, acquiring or developing complementary assets usually takes time, which is an unfeasible situation for most new firms, especially small ones (Ramírez-Alesón & Fernández-Olmos, 2018). Third, competitors may already have assets or be better positioned to develop them (Apa et al., 2017; Hughes, Ireland, & Morgan, 2007).

New firms are motivated to begin their development at incubators to gain access to complementary assets and thus to mitigate the dangers related to the liabilities of smallness and newness (Deeds & Rothaermel, 2003; Fukugawa, 2018; Ramírez-Alesón & Fernández-Olmos, 2018). In addition to the access to offices and laboratories infrastructure, business incubators enable knowledge transfer and inclusion in relationship networks with other firms, customers, and suppliers, providing reputation and legitimacy. Previous studies have found evidence that this environment facilitates relationships with other stakeholders, by providing complementary assets, and is associated with survival and growth, therefore establishing a path dependency and allowing a strengthening of the firm even after leaving the incubation process (Deeds & Hill, 1996; Hughes et al., 2007; Fernandez-Alles, Camelo-Ordaz, & Franco-Leal, 2015; Khodaei, Scholten, Wubben, & Omta, 2022; Rothaermel, 2001; Sköld et al., 2020).

Thus, as posited, incubation benefits their incubatees along four dimensions: (1) development of credibility and legitimacy; (2) shortening of the learning curve, saving time and resources and providing a formalization of processes, contracts, and agency; (3) quicker solutions of problems, and (4) access to networks and alliances (Bruneel et al., 2012; Fukugawa, 2018; Nicholls-Nixon et al., 2022; Khodaei et

al., 2022). These benefits contribute to gaining complementary assets and aims to help entrepreneurs against the main threats they face throughout the development of new firms and strengthen business-incubated firms for survival and growth after graduation at the end of the incubation period. Thus, we can predict that complementary assets provided during the hatching period strengthen graduated firm performance. Accordingly, we state our first research hypothesis as follows:

> **Hypothesis 1.** The supply of complementary assets of business incubators positively impacts graduated firm performance.

Legitimacy is the perception that a company can operate in its environment by conforming to norms, beliefs, and definitions (Navis & Glynn, 2011). Legitimacy is a function of organizational structure, procedures, reputation, communication, and experiences (Suchman, 1995). New firms suffer liabilities of newness and other conditions, expressed as lacking legitimacy (Aldrich & Auster, 1986; Cafferata, Abatecola. & Poggesi, 2009; Freeman et al., 1983). Legitimacy is vital to technology-based companies due to the type of product. This market's mechanisms that make survival and commercial success depend on the endorsement from the technology community (Chen, Qian, & Narayanan, 2017). Previous studies identified the role of legitimacy in technology-based companies' success in the commercialization of software (Garud, Jain, & Kumaraswamy, 2002) and electronic products (Adner & Kapoor, 2016).

New firms often deal with the lack of legitimacy when competing in the market with older established firms. However, tenants can increase their legitimacy in the market by being located within a business incubator (Ratinho, 2011). The legitimacy provided by business incubators occurs through the access to social resources as involvement in networks with specialized suppliers, competitors, and customers, and specific knowledge (Nicholls-Nixon & Valliere, 2020; Nicholls-Nixon et al., 2022; Fukugawa, 2018; Khodaei et al., 2022). Legitimacy should be considered specialized complementary assets (Chen et al., 2017). Entrepreneurs need to integrate with this ecosystem to acquire reputation and legitimacy and become suppliers of established and mature companies (Aernoudt, 2004; Barbero, Casillas, Ramos, & Guitar, 2012). While legitimacy has characteristics of a specialized complementary asset and is configured, for whoever holds it, as a sustainable competitive advantage (Barney, 1991), the incubators' infrastructure is a generic complementary asset.

The infrastructure, composed of subsidized physical space for manufacturing and offices, and communication services, is a standard service offered during incubation and may be considered the most

basic and standard feature of the incubation process, and, thus, a generic asset (Bruneel et al., 2012; Azadnia et al., 2022; Breivik-Meyer et al., 2019; Theodorakopoulos et al., 2014).

The threats inherent to the liabilities of newness and smallness also refer to underdeveloped organizational processes and routines due to the inexperience of the entrepreneur (Apa et al., 2017; Bacalan, Cupin, Go, Manuel, Ocampo, Kharat, & Promentilla, 2019). During the incubation period, firms are helped with the formalization of internal processes, like strategic planning and policy formulation (Bacalan et al., 2019; Peters, Rice, & Sundararajan, 2004), driving to survival and growth after leaving the incubator, as a specialized complementary asset that will facilitate graduated firms' involvement in the competitive market.

We propose that the prevalence of complementary assets related to legitimacy significantly enhances the performance of business incubators. This perspective is founded on the understanding that legitimacy is a vital resource for start-ups, particularly in technology-based companies, due to the unique nature of their products and the marketplace requirements (Chen et al., 2017). Incubators provide this legitimacy through the access to social resources, such as networks with specialized suppliers, competitors, and customers, as well as imparting specific knowledge (Nicholls-Nixon & Valliere, 2020; Nicholls-Nixon et al., 2022; Fukugawa, 2018; Khodaei et al., 2022). This social legitimacy acts as a specialized complementary asset (Chen et al., 2017) and can be a powerful competitive advantage driver (Barney, 1991).

As start-ups often grapple with the liabilities of newness, such as a lack of legitimacy (Aldrich & Auster, 1986; Cafferata et al., 2009; Freeman et al., 1983), the legitimacy granted by incubators can thus be an essential catalyst in their quest for market success. Access to such specialized complementary assets facilitates the entrepreneurs' integration into the ecosystem, thereby aiding them in acquiring reputation and legitimacy and enabling them to become suppliers to established and mature companies (Aernoudt, 2004; Barbero et al., 2012).

In contrast, the infrastructure provided by business incubators – encompassing subsidized physical space for manufacturing and offices, as well as communication services, can be classified as a generic complementary asset (Bruneel et al., 2012; Azadnia et al., 2022; Breivik-Meyer et al., 2019; Theodorakopoulos et al., 2014). While it forms an essential part of the incubation process, it does not contribute uniquely to the start-ups' legitimacy or competitive edge.

Research in the software industry (Garud et al., 2002) and electronic products (Adner & Kapoor, 2016) lends further weight to the hypothesis that complementary assets related to legitimacy, provided

during the incubation period, strengthen firms by raising their survival chances after graduating and then, positively impact incubator's performance. Thus, incubators should prioritize facilitating the acquisition of legitimacy for the firms they host, recognizing it as a strategic specialized complementary asset that can yield significant benefits for their performance. Accordingly, our second research hypothesis is stated as follows:

> **Hypothesis 2**. The predominance of specialized complementary assets related to legitimacy over the others offered by the incubators positively impacts graduated firms' performance.

Infrastructural assets, consisting of physical space for businesses, offices, and communication services, are a universal offering from business incubators, composing the most fundamental and standard part of the incubation process provided to firms (Breivik-Meyer et al., 2019; Nicholls-Nixon & Valliere, 2020; Theodorakopoulos et al., 2014). As such, they are classified as generic complementary assets. Although necessary, these assets do not differentiate the incubator or contribute to the distinctive competitive advantage of their host businesses (Barney, 1991; Chiu et al., 2008).

By overemphasizing infrastructural facilities at the expense of specialized assets, incubators risk failing to meet the distinctive needs of their firms (Bruneel et al., 2012; Peters et al., 2004). Consequently, an undue or oversized focus on these generic assets, such as physical space and communication services, may negatively impact the performance of graduated firms that lacked more specialized resources in the incubation period and negatively affect business incubators' performance. Thus, effectively balancing and prioritizing technical and generic assets are essential for maximizing the incubation process performance, providing a greater probability of survival to graduated firms (Peters et al., 2004). Therefore, we state our third research hypothesis as follows:

> **Hypothesis 3.** The predominance of generic complementary assets related to infrastructure over the others offered by the incubators negatively impacts graduated firms' performance.

Liabilities of newness and smallness encompass elements such as legitimacy, structure, and formalization. By addressing these liabilities, business incubators are aligning with previous studies and extend the understanding of how these factors influence firm performance (Bakker & Josefy, 2018; Balau, van der Bij, & Faems, 2020; Vershinina, Rodgers, Tarba, Khan, & Stokes, 2020). In the context of newness, the lack of formalization in organizational processes, routines, and managerial roles can present significant challenges to the survival of new firms (Apa et al., 2017; O'Toole & Ciuchta, 2020). This lack of formalization, exemplified by the absence of R&D or formal strategic planning, confers an organic characteristic that can hinder the firm's competitiveness (Bacalan et al., 2019).

The introduction of formalization into a firm's operations by the incubator - encompassing areas such as process standardization, planning, and monitoring systems - can be a valuable complementary asset. Formalization can also aid the structure of a new company that needs to consume resources to adjust and adapt to its operational environment (Breivik-Meyer et al., 2019). Therefore, emphasizing formalization as a specialized complementary asset by incubators can transform the effect of size and age on firm performance, positively impacting firms' performance even after graduating. Accordingly, our fourth research hypothesis is formulated as follows:

> **Hypothesis 4.** The predominance of specialized complementary assets related to formalization over the others offered by the incubators positively impacts graduated firms' performance.

Previous research studied the efficacy of environmental characteristics on entrepreneurial activities (Amezcua et al., 2020; Autio et al., 2014; Zahra et al., 2014). The interplay between the incubation process and its geographical context influences new firms' survival (Amezcua et al., 2020). The entrepreneurial environment provides conditions that potentialize incubation results, as it is characterized by positive agglomeration activities of input sharing and quick access to resources due to its abundance of generic and specialized assets (Amezcua et al., 2020). It also provides easy access to resources, favorable public policies and professional support services, facilitating the provision of complementary assets by the incubators (Delic et al., 2012). Such an environment encourages cooperative networks between incubated and graduated companies, thereby providing access to knowledge, capital credit, access to development agencies, and involvement in social networks. The resulting benefits include enhanced legitimacy and more efficient use of resources (Cooper, Hamel & Connaughton, 2012).

Additionally, empirical evidence suggests that firms operating within an entrepreneurial environment are better equipped to weather market uncertainties and perform better overall (Guerrero, Urbano & Gajón, 2017; Cooper et al., 2012). This fact is partly due to the moderating role of the entrepreneurial environment, which enhances the relationship between the provision and effectiveness of complementary assets during the incubation and their tenants' performance.

The complementary assets, coupled with the incubator environment, can foster interactions with stakeholders and positively correlate with survival and growth, especially in innovation and product development to tenants and, further, to graduates (Deeds & Hill, 1996; Hughes et al., 2007; Fernandez-

Alles, Camelo-Ordaz, & Franco-Leal, 2015; Khodaei et al., 2022; Rothaermel, 2001; Sköld et al., 2020). Accordingly, our next research hypothesis is stated as follows:

> **Hypothesis 5a.** The entrepreneurial environment positively moderates the relationship between the provision of complementary assets made available by the incubators and the graduated firms' performance.

Research suggests that business incubators provide start-ups with legitimacy through access to social resources such as networks with specialized suppliers, competitors, and customers, and through the imparting of specific knowledge (Nicholls-Nixon & Valliere, 2020; Nicholls-Nixon et al., 2022; Fukugawa, 2018; Khodaei et al., 2022). The entrepreneurial environment can positively moderate this relationship by enhancing access to resources, fostering cooperative networks, and supporting a favorable ecosystem for start-ups (Amezcua et al., 2020; Delic et al., 2012). This environment facilitates entrepreneurs' integration into the ecosystem, helping them to gain reputation and legitimacy and enabling them to become suppliers of established and mature companies (Aernoudt, 2004; Barbero et al., 2012).

Empirical evidence from the software and electronic products industries supports the hypothesis that legitimacy-related complementary assets positively impact incubator performance (Garud et al., 2002; Adner & Kapoor, 2016). Therefore, business incubators should prioritize providing legitimacy-related complementary assets in an entrepreneurial environment, recognizing them as strategic resources that can substantially enhance their tenants' performance. Accordingly, our next research hypothesis is stated as follows:

> **Hypothesis 5b.** The entrepreneurial environment positively moderates the relationship between the predominance of specialized complementary assets related to legitimacy made available by the incubators and the graduated firms' performance.

A favorable entrepreneurial environment, characterized by easy access to resources (financial, infrastructural, or technological), favorable public policies, and professional support services (Amezcua et al., 2020; Delic et al., 2012) promotes cooperative networks among incubated and graduated firms, facilitating access to knowledge, capital credit, and recognition from suppliers and development agencies (Cooper et al., 2012). This environment can heighten the value of the infrastructural assets provided by the incubators. Even generic assets like physical spaces or communication services can become part of a broader ecosystem of resources, increasing their value to the start-ups and thereby positively influencing the performance of the tenants and graduated firms (Guerrero et al., 2017; Cooper et al., 2012).

Furthermore, the entrepreneurial environment may encourage incubators to balance the provision of assets effectively. It may facilitate interactions that would guide incubators in prioritizing the unique needs of each company they support (Deeds & Rothaermel, 2003; Fukugawa, 2018; Ramírez-Alisón & Fernandez-Olmos, 2018). Accordingly, our next research hypothesis is stated as follows:

> **Hypothesis 5c**. The entrepreneurial environment positively moderates the relationship between the predominance of generic complementary assets related to infrastructure made available by the incubators and the graduated firms' performance.

Start-ups often grapple with the challenges associated with newness and smallness, including the lack of formalization in operational and administrative processes and routines (Apa et al., 2017; Breivik-Meyer et al., 2019; Bakker & Josefy, 2018). The absence of formalization, reflected in the lack of R&D or formal strategic planning, could confer an organic characteristic on these firms, potentially compromising their competitiveness (Bacalan et al., 2019).

The role of business incubators introducing formalization into firm's operations could facilitate the standardization of processes, implement planning, and set up monitoring systems, thereby serving as valuable complementary assets (Breivik-Meyer et al., 2019). By mitigating the challenges inherent to new firms, this formalization can reduce risks, lead to cost efficiencies, and enhance competitiveness, thus improving overall firm performance. However, the extent of these benefits could depend on the entrepreneurial environment that surrounds these incubators. A favorable entrepreneurial environment characterized by abundant resources (financial, structural, or technological), favorable public policies, and professional support services can enhance these benefits (Amezcua et al., 2020; Delic et al., 2012). This environment promotes cooperative networks among incubated and graduated companies, facilitating knowledge exchange, increasing the access to capital credit and aiding the recognition from suppliers and development agencies (Cooper et al., 2012). Such a supportive environment can ease the implementation of formalization processes and enhance the value of these complementary assets offered by the incubators.

Moreover, in a conducive entrepreneurial environment, business incubators can benefit from insights and best practices shared by other ecosystem actors, helping them to optimize the formalization processes that they facilitate (Guerrero et al., 2017; Cooper et al., 2012). Such collective learning and knowledge sharing can further bolster the effectiveness of the incubators' services, resulting in improved performance. Accordingly, our next research hypothesis is stated as follows:

Hypothesis 5d. The entrepreneurial environment positively moderates the relationship between the predominance of specialized complementary assets related to formalization made available by the incubators and the graduated firms' performance.

The conceptual model and the research hypothesis under study are presented in Figure 3.1.

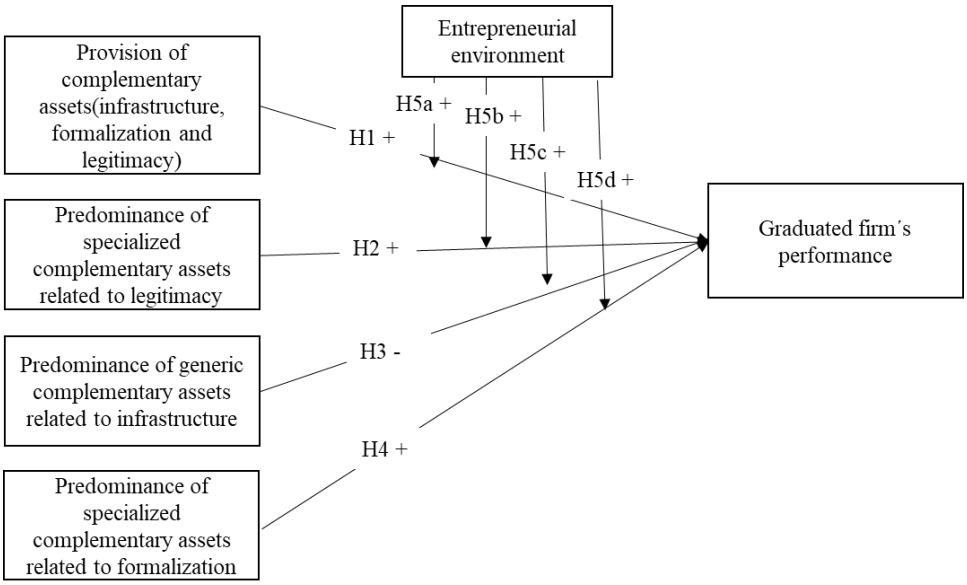


Figure 3.1. Conceptual model
Source: own elaboration

3.3 Methodological framework: Data analysis and methodology

3.3.1 Data collection and sample

We collected the data from multiple sources. We used the support service database for science parks and incubators (Monitoring System for Technology Parks and Business Incubators - SAPI) hosted on the portal "Innovation" of the Brazilian Ministry of Science and Culture (portalinovacao.mct.gov.br). This database, which focuses on business incubators, includes data on the performance of incubators and graduated firms' survival. Additional data from the websites of each incubator was also collected, such as size, services and infrastructure facilities offered. Additionally, we collected data directly from the incubators between May and June 2020.

Of the 129 incubators in the SAPI database, we excluded those that did not have at least one of the variables of interest in our study, basically the occupation rate or data about graduated firms. We excluded twenty incubators for a final sample of 109 incubators spread over all Brazilian states, bringing

an expected variance for our model. Brazil is the largest Latin-American country, with an area of 8,5 million km^2 and about 210 million people, and geographic regions with huge differences among them, in terms of economy, development, and entrepreneurial policies. This fact gives this study the necessary range of variance. Our focus on Brazilian incubators also comes to fulfill the gap of a need for empirical evidence on incubation practices in developing countries (Nagano, Stefanovitz, & Vick, 2014).

3.3.2 Analysis procedures

We constructed a database using Excel software to test the hypotheses, with the information extracted and validated. The method used was multiple linear regression using the SPSS software, version 26. We adopted the least-squares method to test the hypotheses in this article. It is necessary to have a ratio between observations and independent variables varying from a minimum of 5:1 to an ideal of 15:1 to enable the generalization of the results, with a statistical power of 0.80 (risk of not incurring a type II error and avoiding random capitalization) (Hair et al., 2019). We used a maximum of eight predictive variables (four independent and four controls) with the need for a minimum of 40 observations to be employed, with an ideal of 120 observations. As we used 109 observations, the results are protected from choice bias and can be generalized as a priori.

We also adopted two tests to guarantee the quality of the sample. The first was to identify possible outliers. Outliers may bias a model because they affect the estimated regression coefficients. To this end, we used the test with the standardized residuals. The test did not identify any residual with a value higher than 1.96, indicating that the model adequately represents the data. The other test was conducted to identify possible multicollinearity using VIF (variance inflation factors) (Neter, Kutner, Nachsteim, & Wasserman, 1996). All the values obtained were lower than 3, with no identification of multicollinearity.

Robustness check

Our robustness procedure, a comprehensive series of checks, thoroughly assessed the validity of our regression models and the chosen estimation method, instilling confidence in the robustness of our research.

Regarding the regression models estimated by OLS, the procedure evolved over several steps. The first step consisted of assessing the significance of each independent variable through regressions of the dependent variable on each independent variable. The second step consisted of regressing the dependent variable on all the independent variables identified in the previous stage as statistically significant. The third step consisted of a backward estimation procedure through which the model was estimated after removing the most non-significant independent variable until all the independent

variables present were statistically significant. We kept all the original variables as any changes occurred neither in the coefficients nor in statistical significance. All parameters were estimated with robust standard errors to guarantee homoscedasticity.

Further, we conducted Ramsey Regression Equation Specification Error Test (RESET) (Ramsey, 1969). This test determines whether the functional form of the regression is appropriate. In other words, we tested whether the relationship between the dependent and independent variables should be linear or whether a non-linear form would be more appropriate.

In order to validate the chosen estimation method (OLS), we conducted all models using Beta regressions, a carefully selected method that suits the nature of our dependent variable, a proportion varying between 0 and 1. Beta regression, widely used for its flexibility and range-confined predictions, has applications in various academic fields, including economics, management, and health science (Ferrari & Cribari-Neto, 2004). Despite the unavailability of this regression in the SPSS software, we conducted it in R Studio. The results obtained using Beta regression were consistent in terms of statistical significance and the nature of the impact of the independent variable on the dependent variables to those using OLS regression, reinforcing the reliability of our chosen method. See Appendix 2 to Beta regression results.

3.3.3 Variables

Dependent variable

The dependent variable assesses the graduated firms' performance, from which we proxy the incubator performance. Two reasons led us to use this approximation. First, we focus on the interface between the incubator and the graduated firms to what they load for their operation outside the incubation environment due to the competence and capabilities they developed through the complementary assets they were provided (Sydow, Schreyögg, & Koch, 2009). Therefore, our focus should be on the type of complementary assets available to each incubator. Second, an incubator's performance is directly linked to the success of the firms that it graduates (Mas-Verdú *et al*., 2015). We calculated it by observing the number of graduated firms and how many remain active after three years. This is a standard indicator for measuring the efficiency of an incubator (Aerts et al., 2007; Ferguson & Olofsson, 2004; Lasrado et al., 2016; M'Chirgui et al., 2018; Mian, 1997; Torun et al., 2018; Vanderstraeten et al., 2016). We collected the data from the SAPI database for the 109 incubators that were validated. We used the ratio of active firms and all graduates after three years of graduation.

Independent variables

We distinguished the complementary assets provided by the incubators into three groups: infrastructure, formalization, and legitimacy, which are the essential tangible and intangible components of the incubation process described in the literature (*e.g.*, Ahmad & Thornberry, 2018; Allen & McCluskey, 1991; Azadnia et al., 2022; Bruneel et al., 2012; De Oliveira & Terence, 2018; Hackett & Dilts, 2004; Lasrado et al., 2016; Torun et al., 2018; UKBI, 2017). The components that make up these groups were identified and collected through searches of the incubators' websites, listed in Table 3.1, and they are in line with previous studies on the services provided during incubation (e.g., Galiyeva & Fuschi, 2018; Mian, Lamine, & Fayolle, 2016; Pauwels et al., 2016; Soetanto & Jack, 2013). The components of the infrastructure group are assets related to subsidized and shared facilities (office space and services, parking facilities, labs, and operating equipment); the formalization group is linked to coaching, mentoring, counseling, and management and trade training; the legitimacy group is linked to promoting, strengthening, and encouraging networking and reputation with clients, suppliers and credit and development agencies.

Drawing on the complementary assets' focus, one can identify the benefits an incubator provides linked to subsidized and shared facilities as a generic complementary asset, therefore more likely to be offered and not becoming a strategic differential. On the other hand, aspects regarding reputation and legitimacy leading to efficient networking and contributing, for instance, to market insertion, are seen as decisive for the successful incubation process (McAdam & McAdam, 2008) and as a specialized complementary asset. Calculating the values of these three variables (infrastructure, formalization, and legitimation) is based on counting the frequency with which these variables are offered during the incubation process obtained through our sample (Table 3.2). The predominance of the variable is related to the relative participation of the variable concerning the others.

We tested the robustness of our data by collecting the same information directly from the incubators. For this purpose, we built an instrument with questions regarding the types of services provided to graduated firms.[7] We sent it to all the 109 incubators of our sample, and we received 34 forms back, obtaining an index of return of 27,5%. Missing data analysis indicated that four cases missed 60% or more of the variables, but all were without data on the dependent variable. We did not consider these four forms to avoid an artificial increase in the independent variables' relationships with the dependent variable (Hair et al., 2019). Thus, the final sample was made up of 30 business incubators. A paired-sample t-test confirms that no significant differences exist between the distribution of the measures

[7] See Appendix 1

provided by the incubator managers through our form and those on the incubator websites included in the sample of 109 business incubators (Table 3.3). This makes us confident that we had no problems regarding common method variance for the performance measures.

Table 3.2. Complementary assets provided

Dimensions	**Observable variables**[8]
Infrastructure	Office (physical space)
	Office services (reception, equipment, connection)
	Parking
	Production equipment
	Laboratories
Formalization	Coaching
	Mentoring
	Business consulting (management, marketing)
	Training in management
	Commercial training
Legitimacy	External professional services (patents, accounting, consultancies)
	Access to financial agents (angel investors, banks, development agencies)
	Access to the supplier network
	Access to the customer network
	Access to shows and trade fairs

Further, we compared the information we received with those obtained from the main sample websites for validation. After we discussed the identification criteria for the items' characteristics, we individually validated and compared the results. We obtained a Cohen-Kappa coefficient of agreement of 95% (Cohen, 1960). We clarified any doubts regarding inclusion by telephone calls to the managers in charge of the incubators.

Table 3.3. Paired-sample t-test

	Performance	**Infrastructure**	**Formalization**	**Legitimacy**
t-statistics	0.99	0.83	0.27	0.81
p-value	0.26	0.18	0.06	0.10

[8] Sources: Amezcua et al. (2013); Azadnia et al. (2022); Bruneel et al. (2022); Chan and Lau (2005); Mian et al. (2016); Peters et al. (2004); Siddiqui et al. (2021); Soetanto and Jack (2013); Theodoraki (2022); Theodorakopoulos et al. (2014).

n	30	30	30	30

Source: own elaboration

The entrepreneurial environment refers to the context or conditions in which entrepreneurial activity occurs, and new start-up firms are founded (Bogatyreva, Laskovaia, & Osiyevskyy, 2022; Cooper et al., 2012; Martinez-Fierro, Biedma-Ferrer, & Ruiz-Navarro, 2020; Weiblen & Chesbrough, 2015). We calculated the quality of the entrepreneurial environment using the ratio of start-ups in the incubator's city and the city's population as a proxy. Data on the number of start-ups in each city was obtained from the website of the Brazilian Association of Startups (https://abstartups.com.br) and the population of the cities from the website of the Brazilian Institute of Geography and Statistics (https://ibge.gov.br), which is the Brazilian government agency for demographic data.

Control variables

We included some control variables at the incubators' level and from the municipalities in which they are located. We had the size, occupation rate, and focus for the incubators. The incubator size can influence access to resources and affect performance concerning the intensity and quality of the complementary assets supported and expressed by the independent variables. Previous studies have shown the impact of size on incubator performance, i.e., on the survival of graduated companies (Allen & McCluskey, 1991; McKinnon & Hayhow, 1998). Following prior studies (e.g., Vanderstraeten et al., 2016), we computed the incubator's size by the surface occupied and was divided into four categories: small, from 1 to 500m²; medium-sized, from 501 to 1000m²; large, from 1001 to 2500m² and extra-large, from 2501 to 10000m². We collected the data for this variable from the incubator's website.

The incubator's occupation rate is a proxy of the relevance of an incubator in its ecosystem due to the attractivity of what is available to the incubatees and their results (e.g., Guadix, Carrillo-Castrillo, Onieva, & Navascués, 2016). Thus, firms initially seek the most important incubators, leading to high occupation rates (Aerts *et al*., 2007). We collected this data from the SAPI database.

Finally, the incubator's focus refers to the orientation of the incubator and is related to the service provided, which may vary the focus during the incubation process (Barbero *et al*., 2012; Barbero, Casillas, Wright, & Ramos Garcia, 2014). Technology-based incubators can be divided into two groups: those with links to universities that explore the potential of this proximity encouraging technological R&D by their incubatees (Soetanto & van Geenhuizen, 2007), and those focused on the market, which seek financial results and do not prioritize aspects related to R&D (Binsawad *et al*., 2019). There is evidence that this difference influences graduated firms' performance in their post-graduation period (Hannon & Chaplin, 2003). We used a dichotomous variable, 0 = market; 1 = university. We collected

this information from the incubators' websites, and the information the incubators' management included on the forms to confirm the information collected from their sites.

We have also included a control at the location level, specifically the cities where the incubators are located: the municipal human development index (MHDI). MHDI has been used to evaluate cities' development and, for example, the ability to attract outside investments is related to the population's potential access to education (Amal, Seabra, & Sugai, 2007). This factor favors entrepreneurship and influences new business creation due to the availability of resources and competencies (Chandler & Jansen, 1992). MHDI measures development based on income, education, and health. Data on the MDHI was extracted from the Brazilian Institute of Geography and Statistics (IBGE). This index ranges from 0 to 1.

Furthermore, the occupancy rate and MHDI variables were squared in order to assess the possibility of different impacts depending on the level of these variables.

3.3.4 Model and estimation procedure

The analysis procedure started with a view of the descriptive statistics and Pearson correlations among all variables. Descriptives showed the sample's main characteristics like minimum and maximum values, mean, and standard deviation. The correlations tested the association between variables; also, they were used to check for collinearity, jointly with the variance inflation factor (VIF) calculation.

We tested our hypotheses using Ordinary Least Squares regression (OLS), which is a common technique for estimating the relationship between one or more independent variables and a dependent variable, considering the following structure for our model:

$$y_i = \alpha_0 + \beta' x + \gamma' z + u$$

where y is the vector of the dependent variable's observations; α_0 is the model's intercept; x and z are the vectors of the independent and control variables, respectively, and β and γ are the vectors containing the respective coefficients; u is error term vector.

We conducted the regression analysis through 10 models. Model 1 included only control variables to show their values and significance without the independent variables. In models 2 to 5, we tested the direct relations between the complementary assets and the graduated firm's performance. Models 6 to 9 tested the interactions, assessing the moderating effect of the entrepreneurial environment on the influence between complementary assets and performance. Finally, model 10 included all independent variables.

3.4 Results

3.4.1 Preliminary analysis

Table 3.4 shows the sample's descriptive statistics and Table 3.5 presents the Pearson correlations between the variables. Although some correlations were significant, there is no correlation higher than 0.80 that could suggest serious collinearity (Field, 2013). Also, as all Variance Inflation Factor (VIFs) are bellow three, there is no evidence of serious multicollinearity.

Table 3.4. Descriptives

	Minimum	Maximum	Mean	Std. Deviation
Performance	0.000	1.000	0.842	0.229
Attributes of infrastructure, formalization and legitimacy	4.000	12.000	8.202	1.586
Predominance of infrastructure attributes	0.250	0.750	0.424	0.094
Predominance of formalization attributes	0.000	0.750	0.318	0.099
Predominance of legitimacy attributes	0.000	0.500	0.259	0.097
Entrepreneurial environment	0.000	0.154	0.039	0.040
Occupation rate	0.000	1.000	0.718	0.242
Focus of incubator	0.000	1.000	0.587	0.495
MHDI	0.624	0.847	0.775	0.041
Small	0.000	1.000	0.523	0.502
Medium size	0.000	1.000	0.248	0.434
Large size	0.000	1.000	0.156	0.364
Extra-large size	0.000	1.000	0.073	0.262
Valid n (listwise)	109.000			

Source: SPSS – Own elaboration

It is important to note that the correlations indicate the path proposed by the hypotheses of this research. Thus, the correlation between performance and the variables related to the supply of complementary assets (infrastructure, formalization, and legitimacy attributes) is positive and statistically significant ($r = 0.293$, $p<0.01$).The correlation between performance and the predominance of specialized assets are positive for formalization attributes, although not statistically significant ($r = 0.097$, $p > 0.05$), but the correlation with legitimacy attributes is positive and significant ($r = 0.223$, $p<.05$). Moreover, and aligned with our hypotheses, the correlation between performance and the predominance of infrastructure attributes, a generic complementary asset, is negative and significant ($r = -0.332$, $p<.01$). It is also worth noting that, as we expected, the correlation between the entrepreneurial environment and performance is positive and significant ($p = 0.304$, $p<0.01$) and between the incubator occupation rate and performance is also positive and significant ($r = 0.603$, $p<0.01$), denoting that the success of an incubator is linked to its occupation rate (Table 3.5).

Table 3.5. Pearson correlations

	1	2	3	4	5	6	7	8	9	10	11
1. Performance	1										
2. Attributes of infrastructure, formalization, and legitimacy	.293**	1									
3. Predominance of infrastructure attributes	-.332**	-.662**	1								
4. Predominance of formalization attributes	0.097	0.124	-.494**	1							
5. Predominance of legitimacy attributes	.223*	.516**	-.467**	-.537**	1						
6. Entrepreneurial environment	.304**	0.069	-0.119	-0.018	0.133	1					
7. Occupation rate	.603**	0.114	-.217*	0.119	0.089	0.108	1				
8. Focus of incubator	-0.009	0.154	-0.015	-0.057	0.073	-0.150	-0.021	1			
9. MHDI	0.039	0.081	0.040	-0.171	0.135	.468**	-.212*	-0.175	1		
10. Medium size	-0.064	-0.046	0.093	-0.188	0.101	0.019	-0.050	-.209*	.188*	1	
11. Large size	0.105	0.041	-0.046	0.103	-0.061	0.131	0.079	-0.050	0.009	-.247**	1
12. Extra-large size	-0.061	-0.081	0.108	-.223*	0.122	0.100	0.025	-0.050	0.027	-0.161	-0.121

Note. * = p < 0.05; ** = p < 0.01
Source: own elaboration

Table 3.6 depicts the complementary assets supported by the incubatees and shows the descriptive statistics of these data. It is important to note that, as expected, aspects linked to infrastructure are the ones most commonly offered by the incubators. Conversely, the specialized complementary assets associated with legitimacy are the scarcest. The ANOVA shows that the groups differ from one another ($p<0.001$).

Table 3.6. Complementary assets - Descriptives

	Structure	Formalization	Legitimacy
Mean	3.376	2.624	2.202
Std. Deviation	0.558	0.901	1.043
Median	3	3	2
Mode	3	3	2
ANOVA (*p-value*)	.000	.005	.000

Source: SPSS

3.4.2 Findings

Table 3.7 presents the results of the multivariate regressions testing the hypotheses. Notably, the statistics of the Reset tests applied in the models were non-significant. The null hypothesis of this test indicates the adequate specification of our models. Model 1 includes only the control variables. The control variable occupation rate's strong, positive, and significant effect is worth noting, suggesting that the most popular business incubators positively impact tenants' performance. The squared value of this variable is also statistically significant, indicating that, despite occupation rate positively impacting performance, it obeys an inverted-U relation, assuming that at a certain point, as occupation rate increases, the effect on performance decreases. Also, the positive coefficient for MHDI, the incubator location city human development index, suggesting that the best incubators choose the more developed cities, but the coefficients were not statistically significant.

Models 2 to 5 test the direct hypotheses, 6 to 9 test the moderation hypotheses, and model 10 is the complete model. In Model 2, we tested Hypothesis 1, suggesting a positive direct effect of incubators' complementary assets on graduated firms' performance. The independent variable coefficient in Model 2 has a strong, positive, and significant effect (0.031, $p<0.01$), confirming H1. Thus, complementary assets and infrastructure facilities provided during incubation have a positive influence on the performance of graduated firms, which is consistent with the idea proposed that incubators provide access to physical infrastructure and give directions to formalize their processes through training and consultancies and promote reputation in the eyes of their stakeholders, prepare better their tenants to achieve better performance after the incubation process.

In Model 3, we tested H2 regarding the predominance of complementary assets associated with legitimacy among all the others. The result was positive and significant (0.402, $p<0.05$), confirming this hypothesis that the predominance of specialized complementary assets associated with legitimacy influences performance, thus identifying their importance among the available assets.

Model 4 tested Hypothesis 3. In this hypothesis, we proposed that the predominance of assets linked to physical infrastructure would negatively influence the performance of graduated companies. We obtained a negative and significant coefficient, thus confirming H3 (-0.480, $p<0.001$). This fact implies that infrastructure facilities risk to be overestimated and should not be considered alone as the most crucial factor in an incubation period.

Model 5 tested Hypothesis 4, which was not confirmed. In this hypothesis, we proposed that assets linked to the preponderance of complementary assets related to formalization would positively

influence the performance of graduated companies. We obtained a positive, although not significant, coefficient (0.104, p = ns), thus rejecting this hypothesis.

Models 6 to 9 tested interactions, using the entrepreneurial environment as a moderator. We performed a moderation analysis for each model to investigate how the entrepreneurial environment moderated the relationship between the provision of complementary assets and the graduated firm's performance. We used two levels (low and high) for moderation and the independent variables. These two levels were calculated using the function resulting from the tested regression and replacing the standardized variables with (-1) and (+1) standard deviation for low and high levels, respectively. The lines in Figure 3.2 show the moderation effect split in these two levels.

Model 6 tested H5a, the moderation between the complementary assets offered in an entrepreneurial environment and performance. We obtained a negative and significant moderation (-0.822, p<0.001), suggesting moderation in the tested relationship. The moderation effect indicates positive moderation for the low levels of the entrepreneurial environment and slightly negative for higher levels. Thus, providing complementary assets in a low entrepreneurial environment drives performance upwards, compensating, in a certain way, for the deficiencies of the environment. (Figure 3.2 – H5a), not rejecting this hypothesis.

Model 7 shows the moderation of the entrepreneurial environment on the predominance of specialized complementary assets linked to legitimacy on graduated firms' performance (H5b). We obtained a negative and significant moderator effect (-1.430, p<0.05). The lines of both levels of the moderator variable are shown in Figura 3.2 – H5b, and the difference in the slopes is worth being noticed. For lower levels, the slope is 3.582, moving performance upwards, and the slope for higher levels is -2,138, dampening the positive relationship between the predominance of assets related to legitimacy and Performance (Figure 3.2 - H5b). This hypothesis is not rejected.

Model 8 tested Hypothesis 5c and showed a positive and significant result (14.272, p<0.001) for the moderating variable, suggesting moderation in the tested relationship. As proposed in the hypothesis, the result indicates positive moderation. Thus, entrepreneurial environment dampens the negative relationship between the supply of infrastructure assets and performance (-0.828, p<0.01) (Figure 3.2 – H5c), therefore not rejecting H5c.

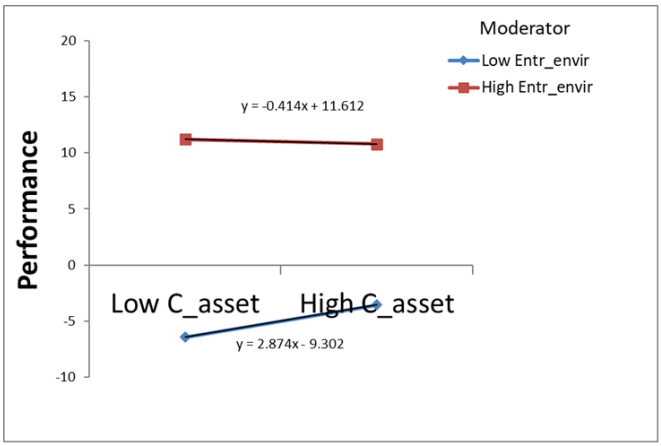
Table 3.7. Regression models for incubator performance

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
Attributes of infrastructure, formalization and legitimacy		0.031***				0.615***				0.046**
Predominance of legitimacy attributes			0.402**				0.361***			0.492
Predominance of infrastructure attributes				-0.491***				-0.938***		0.158
Predominance of formalization attributes					0.104				0.267	0.482
Entrepreneurial environment						7.991***	1.233***	-4.674**	2.399	3.324
Attributes x entrepreneurial environment						-0.822***				-0.530*
Predominance of legitimacy attributes x entrepreneurial environment							-1.430*			-1.168
Predominance of infrastructure attributes x entrepreneurial environment								14.272***		6.259
Predominance of formalization attributes x entrepreneurial environment									-3.982	-0.397
Occupation rate	2.159***	2.144***	2.082***	2.109***	2.162***	2.188***	1.998***	2.127***	2.115***	2.159***
Squared occupation rate	-1.226***	-1.238***	-1.175***	-1.221***	-1.231***	-1.315***	-1.142***	-1.260***	-1.223***	-1.290***
Focus of incubator	0.026	0.009	0.004	0.027	0.029	0.018	0.017	0.018	0.0311	0.011
MHDI	-5.995	-8.187	-6.960	-8.002	-5.861	-11.074	-4.029	-8.069	-1.752	-9.552*
Squared MHDI	4.561	5.907	5.017	5.885	4.494	7.395	2.892	5.539	1.385	6.427*
Medium size	-0.001	0.002	-0.017	0.010	0.005	0.037	-0.016	0.021	0.008	0.024
Large size	0.011	0.008	0.016	0.013	0.011	0.018	0.002	-0.012	-0.004	0.007
Extra-large size	-0.096	-0.081	-0.135**	-0.073	-0.085	-0.078	-0.131*	-0.085	-0.108*	-0.088
R^2	0.522	0.565	0.551	0.560	0.524	0.625	0.584	0.614	0.554	0.641
Adjusted R^2	0.484	0.525	0.506	0.520	0.481	0.582	0.536	0.570	0.503	0.574
Reset test (*p-value*)	0.258	0.663	0.431	0.869	0.374	0.430	0.175	0.541	0.351	0.217
Significance of the regression	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
n.	109	109	109	109	109	109	109	109	109	109

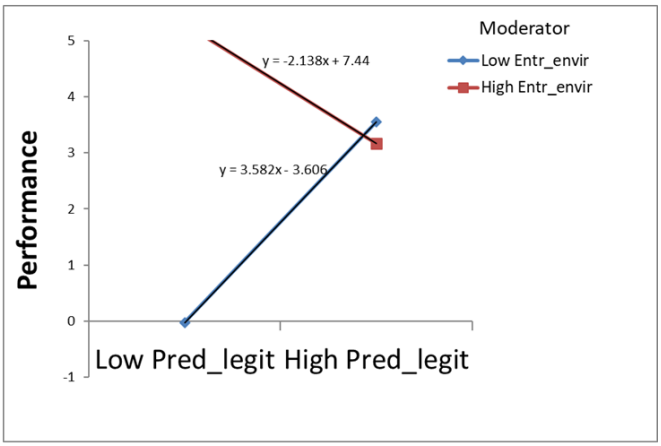
Note 1. † = p < 0.1; * = p < 0.05; ** = p < 0.01; *** =p<0.001

Note 2. Regression conducted using Heteroscedasticity-robust standard errors, variant HC3

H5a



H5b



H5c

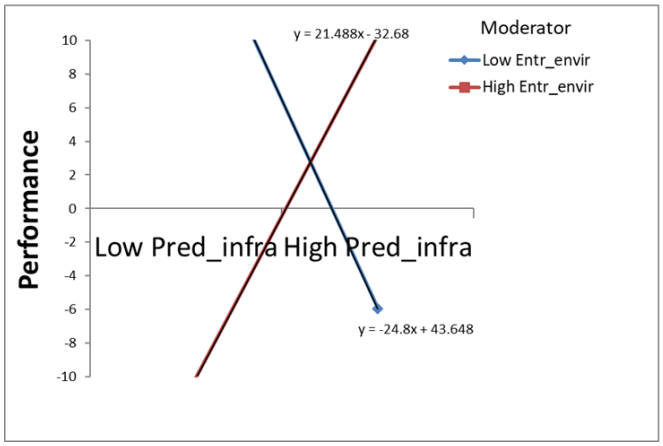


Figure 3.2. Moderation effects
Source: MS Excel

Model 9 tested H5d, and the interaction between the predominance of formalization-related complementary assets was not significant (-2.312, p = ns), resulting in a rejection of this hypothesis. Finally, Model 10 included all variables, confirming the moderation between the predominance of legitimacy attributes over the others, a specialized complementary asset, and performance, hypothesis 5b. It also confirms the influence of the occupation rate. Table 3.8 summarizes all our results.

Table 3.8. Hypotheses testing summary

	Hypotheses	**Results**
H1	The supply of complementary assets of business incubators positively impacts graduated firm performance.	Not rejected
H2	The preponderance of specialized complementary assets related to legitimacy over the others offered by the incubators positively impacts graduated firms' performance.	Not rejected

H3	The predominance of generic complementary assets related to infrastructure over the others offered by the incubators negatively impacts graduated firms' performance.	Not rejected
H4	The predominance of specialized complementary assets related to formalization over the others offered by the incubators positively impacts graduated firms' performance.	Rejected
H5a	The entrepreneurial environment positively moderates the relationship between the provision of complementary assets made available by the incubators and the graduated firms' performance.	Not rejected
H5b	The entrepreneurial environment positively moderates the relationship between the predominance of specialized complementary assets related to legitimacy made available by the incubators and the graduated firms' performance.	Not rejected
H5c	The entrepreneurial environment positively moderates the relationship between the predominance of complementary assets related to infrastructure made available by the incubators and the graduated firms' performance.	Not rejected
H5d	The entrepreneurial environment positively moderates the relationship between the predominance of specialized complementary assets related to formalization made available by the incubators and the graduated firms' performance.	Rejected

Source: own ellaboration

3.5 Discussion, conclusions, practical implications, limitations, and future research

3.5.1 Discussion and conclusions

This study analyzed how complementary assets provided during the incubation process influence graduated firms' performance and, consequently, incubators' success. Graduated firms refer to firms after leaving an incubation period. For this purpose, we used technology-based firms that were provided with complementary assets in their development, during the incubation period. By definition, business incubators are providers of these assets aiming to hatch tenants' firms to mitigate typical threats of being small and young (Bruneel et al., 2012; Azadnia et al., 2022; Breivik-Meyer et al., 2019; Theodorakopoulos et al., 2014). In this research, following previous studies (Aerts et al., 2007; Ferguson & Olofsson, 2004; Lasrado et al., 2016; M'Chirgui et al., 2018; Mian, 1997; Torun et al., 2018; Vanderstraeten et al., 2016), we assess the success of incubators, in terms of the incubation process, by the survival of their former tenants. We investigated the effect on survival by dividing complementary assets into specialized and generic ones and evaluating their relevance depending on the type of asset and its preponderance over the other assets offered during the incubation process.

To varying degrees, business incubators strive to offer their incubated companies infrastructure and expertise by providing physical spaces, support services, consultations, and advisory services. These efforts help to address the challenges that impact the survival and growth of the incubated firms, with these services being regarded in this study as complementary assets. A characteristic of complementary

assets is that they “make the difference” between the success and failure of an operation, a new process, or a new product (Teece, 1986), and they can be classified as generic, being those which do not need to be adapted and can be obtained on the market or quickly built internally, or specialized, being those which require a long development and resource expenditure and are difficult to replicate (Teece, 1986; Teece et al., 1997). We argued that the acquired complementary assets should neutralize the threats faced by small and new firms.

The results show that complementary assets positively influence the survival of graduated companies by mitigating liabilities of newness and smallness. We divided the services provided during incubation into three groups regarding their characteristics: (1) infrastructure (physical facilities such as spaces and office support services), (2) formalization (establishment of processes and roles), and (3) legitimacy (access to relationship networks) (Ahmad & Thornberry, 2018; Allen & McCluskey, 1991; Azadnia et al., 2022; Bruneel et al., 2012; De Oliveira & Terence, 2018; Hackett & Dilts, 2004; Lasrado et al., 2016; Torun et al., 2018). Infrastructure can be classified as a generic complementary asset and others as specialized complementary assets.

The findings indicate that firms achieve better performance after the incubation period when they are provided with services during incubation that foster the development of specialized complementary assets. This improvement is primarily due to their integration into relational networks with stakeholders and their enhanced reputation in the financial market and among potential competitors. In our hypotheses, legitimation proved to be a factor for survival success of graduated firms and, consequently, a success factor for business incubators. Generic complementary assets provided, when preponderant over the others, are not decisive for the survival of graduated firm. On the contrary, they bring a negative component, probably due to the lower supply of specialized assets.

We also tested aspects related to formalization, which, being a specialized complementary asset, could, like the acquisition of legitimacy, be decisive in strengthening former incubators. Aspects linked to the formalization of routines probably do not have a degree of specialization, such as acquiring legitimacy, therefore being a less specialized asset. Our hypothesis was rejected. Future research may address this topic of relevance to firms' internal operations since, as they are still new, they have not yet developed skills related to the formalization, for example, of decision-making processes, managerial roles, and strategic planning.

As suggested by Amezcua et al. (2020), we tested the role of the environment in which the incubator is inserted. We used the entrepreneurial environment of the locations, determined by the

relationship between the number of start-ups and the population. We tested the strength of moderation in this type of context on the influence between the complementary assets provided and the performance of graduates. Our hypotheses regarding the moderation between the provision of total complementary assets and the existence of a predominance of assets linked to legitimacy and infrastructure have not been rejected. The decomposition of the moderating variable proved our point that, in environments with low entrepreneurial activity, the predominance of assets linked to legitimacy positively impacts performance, increasing graduates' probability of survival. In contexts with low entrepreneurial activity, the incubator's role in developing legitimacy-related competencies is more crucial. On the other hand, we found a dampening effect on performance in contexts with high entrepreneurship due to the contextual characteristics themselves.

The moderation between the predominance of aspects related to infrastructure and the entrepreneurial environment showed that when environmental entrepreneurship is high, the predominance of infrastructure assets over the others dampens the negative effect on performance since, in this environment, more accessible facilities are found for the development of competences linked to legitimation. On the other hand, in environments of low entrepreneurial activity, the preponderance of the supply of infrastructure assets over the others reduces performance since the greatest need is linked to obtaining specialized complementary assets. This study complements Amezcua *et al.* (2020) as it identifies, for the same entrepreneurial environment, but with different intensities, the various effects of the environment on the survival of firms that went through incubation and, consequently, impacting the success of the incubators themselves.

To be concise, this work contributes to studying the survival of graduated firms, the determinants of incubation success, and entrepreneurship in two ways. First, it shows the role of each type of complementary asset in the survivability of graduated firms. We proved that the type and intensity of a complementary asset provided during the incubation process are crucial for the hatching period to be successful. The incubator's success is linked to the survival of its tenants after leaving the incubator. We also found the relationship between the entrepreneurial environment and the required characteristics for incubation success. The second contribution lies on the evidence that gains stemming from complementary assets are more relevant when the type of asset is linked to legitimacy.

3.5.2 Practical implications

This study contributes significantly to the management of firms and business incubators by shedding light on various aspects of the incubation process. We provide substantial evidence of the

pivotal role played by the characteristics of services offered within incubators. This newfound understanding challenges the conventional wisdom that emphasizes the importance of providing extensive infrastructure facilities.

One of the key findings of our study is that although infrastructure facilities play an essential role in supporting start-ups, their dominance in the incubation process may be less effective than previously believed. Instead, our research underscores the critical role of legitimacy-related issues in the success of incubated firms. This suggests that fostering an environment where start-ups can gain trust, credibility, and recognition is just as vital, if not more so, than merely offering physical resources.

Furthermore, our research has broader implications beyond the realm of incubation itself. It extends to the formulation of development policies for entrepreneurship at large. Policymakers and business development agencies can better direct their efforts by recognizing the significance of legitimacy-related factors. They can offer more targeted support and guidance to budding entrepreneurs, tailoring their assistance to address the complex issues related to legitimacy, credibility, and trust-building. This approach not only fosters start-ups formation but also improves the overall success rate of these ventures.

In conclusion, our study underscores the multifaceted nature of business incubation and its implications for firm management, incubator operation, and entrepreneurship development. It challenges conventional thinking and suggests that a balanced approach, which incorporates both infrastructure and legitimacy-related support, is crucial for the sustainable growth of start-ups. As we gain insights into the dynamics of the start-up ecosystem, these findings will prove valuable for those involved in supporting and nurturing entrepreneurial behavior.

3.5.3 Limitations and future research

The low number of respondents used in the analysis is a limitation of this study. Despite a specific variance in the sample, a higher number of observations would help to obtain more robust results and provide greater clarity regarding the unconfirmed hypotheses and non-valid models. Moreover, Brazil has substantial regional differences, so the sample did not homogeneously include all of its diversity, although we adopted regional characteristics such as the MHDI for control. These limitations are correlated, as both are resolved through sample enlargement. Future studies should consider an even distribution of observations for each region of the country. As Brazil is a developing country, future research should investigate countries with diverse economic status and compare the findings. Finally, another limitation lies in the fact that we have no information on pre-incubation capabilities and ties and,

therefore, we cannot say whether the incubation process helped start-ups to accumulate internal and external resources or exploit existing ones. Future studies should consider this issue.

New studies could evaluate moderating effects, such as the incubator's focus on graduated companies' performance or nationality, comparing access to complementary assets and performance in distinct cultural and economic contexts. Furthermore, the role of the infrastructure offered by business incubators needs better evaluation, as incubators with the best infrastructure do not always "generate" more healthy firms, as shown in our research.

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Chapter 4 – Determinants of Business Incubator Success in Diverse Institutional Environments: A Comparative Analysis of Brazil and Portugal[9]

ABSTRACT

Purpose – This research aims to present a comparative study of business incubation practices in Brazil and Portugal and assess incubation success drivers. It proposes an identification and assessment of business incubators' performance practices.
Design/methodology/approach – The study uses non-parametric mean comparison tests to conduct our analyses, using a sample of 109 Brazilian and 52 Portuguese business incubators.
Findings – The findings suggest differences between the incubation processes in both countries concerning the provision of office infrastructure facilities aid to formalize operational routines, and counseling to network for the acquisition of reputation in the business environment. Additionally, our results suggest the influence of diverse institutional contexts between the two countries on the determinants of business incubator success.
Practical implications – Based on the results of this study, incubator managers can improve their incubation process, and entrepreneurs can have more information to select a business incubator. We also bring information for those entrepreneurs who intend to develop a company outside their country and who wish to seek incubation services in Brazil or Portugal.
Originality/value – This study borrows the concept of complementary assets to identify whether business incubators' performance drivers are diverse in Brazilian and Portuguese business incubators. The institutional context of both countries is considered in determining the distinct role of incubation services offered.

Keywords: Business incubators; complementary assets; Brazil; Portugal; non-parametric tests.

4.1 Introduction

Business incubators (BIs) play a significant role worldwide in helping new firms to pursue their economic and social challenges. BIs firstly began in the US in the 1960s and later developed in the UK and Europe through various related forms, such as innovation centers and techno poles and science parks (Hassan, 2020; Sanyal & Hisam, 2018). By helping to develop new business models, innovative products, and services, these organizations foster entrepreneurial activities and provide a supportive ecosystem for newly founded firms to succeed, reducing their vulnerability (Meyer & Sowah, 2020; Sedita, Apa, Bassetti, & Grandinetti, 2018; Stinchcombe, 1965). They also stimulate and strengthen economic development, generating jobs and wealth (Amirahmadi & Saff, 1993; Phan, Siegel, & Wright, 2005). They help new firms not only acquire technical, professional, and financial support internally or

[9] Submitted to the Journal of Small Business and Enterprise Development; submitted to the 2024 Academy of Management Annual Meeting and to the EURAM 2024 Annual Conference.

externally to the incubator at lower costs (Bruneel, Ratinho, Clarysse, & Groen, 2012), but also to overcome the liability of newness by integrating the tenant firms into a network environment (Sedita et al., 2018; Stinchcombe, 1965). Establishing network relationships during incubation is essential for new ventures since the incubator's network can better meet diverse needs of new firms and bring benefits like a rich resource flow, lower transaction costs, and high-quality alliance partners. Moreover, it would also help new firms to accelerate their learning curve and growth (Wu, Wang, & Tsai, 2020).

The incubation process refers to a concerted, systematic effort to nurture new firms in the early activity stage in a controlled environment. It offers a combination of infrastructure, development-support processes, and expertise to safeguard against failure and steer incubated firms into a growth path (Tötterman & Sten, 2005; Theodorakopoulos, Kakabadse, & McGowan, 2014; UKBI, 2012). The success of the incubation process can be measured, as it produces successful firms that will graduate and be financially viable and independent (Aernoudt, 2004; Torun, Peconick, Sobreiro, Kimura, & Pique, 2018). Therefore, we can assess the success of the incubation period through certain characteristics such as promoting job creation (Amezcua, Ratinho, Plummer, & Jayamohan, 2020; Ayatse, Kwahar, & Iyortsuun, 2017; Lukeš, Longo, & Zouhar, 2019), new ventures development (Kwapisz, 2022; Lukeš et al., 2019), supporting the entrepreneurial community (Bruneel et al., 2012) and fostering economic development (Amezcua et al., 2020; Kiran & Bose, 2020; Phan et al., 2005; Schwartz & Gothner, 2009; Sehitoğlu & Ozdemir, 2013). Hence, the primary purpose of business incubation is to contribute to economic development by helping firms survive beyond the incubation period (Torun *et al*., 2018).

Due to a roller-coaster of business incubators practices and hatching methodologies spreading widely, many countries pursue strategies to support incubation programs through experimentation, public policies, triple helix, coopetition alliances, or technological programs (Alon & Godinho, 2017; do Amaral, da Hora, Messias, Andrade Cunha, & Maia, 2020; Kreusel, Roth, & Brem, 2018; Santos, 2022). BIs play a crucial role in fostering the growth of start-ups by providing a supportive environment that nurtures innovation and entrepreneurship. These incubators serve as a launching pad for emerging businesses, offering a range of complementary assets and services (Theodorakopoulos et al., 2014).

Complementary assets are supporting resources, capabilities, or skills, physical, human, or organizational, which can be classified as physical infrastructure offered, support on formalization processes, and support on the search for legitimacy, allowing firms to gain benefits, usually financial, associated with a strategy, technology, or innovation (Reyes-Rodríguez & Ulhøi, 2022; Taylor & Helfat, 2009; Teece, 1986). Extant literature argues that the success of incubators is linked to the survival of new companies after the incubation process (Vanderstraeten, van Witteloostuijn, Matthyssens, & Andreassi,

2016). By considering the benefits of the incubation process as complementary assets transferred to the incubatee (Bruneel et al., 2012; Fukugawa, 2018; Nicholls-Nixon, Valliere, Singh, & Hassannezhad Chavoushi, 2022; Khodaei, Scholten, Wubben, & Omta, 2022), the success of former tenants is associated with what they received during incubation and thereby the incubators' performance is evaluated.

Although business incubators' impact on economic development has been widely researched, just a few studies rely on the incubation practices of Brazil and Portugal, taking the countries separately or together. In a search conducted in two major databases, Web of Science (webofknowledge.com) and Scopus (scopus.com), we found just one qualitative research comparing incubation processes in Brazil and Portugal (Carvalho & Galina, 2015). Despite having cultural similarities and historical interweaving, Brazil and Portugal have different institutional contexts, probably leading to different practices in business incubation services (IPD, 2016). BIs play a relevant role in both countries. In Brazil, data from 2018 state that approximately 370 business incubators, through their tenants, generated 14,500 jobs, and data from 2022 show that, in Portugal, there were 2,600 start-ups in 150 incubators with the generation of more than 10 thousand workstations (data from Brazil – agenciabrasil.ebc.gov.br – and Portugal – portugaldigital.gov.pt – government agencies). This study empirically identifies a ranking of preferred incubation services in Brazil and Portugal by conducting cross-country research using surveys and secondary data. It describes and classifies a set of services provided by a sample of Brazilian and Portuguese business incubators. Comparative research between these two countries is scarce, particularly within the same development spectrum.

Departing from this gap, this study contributes to the literature by answering the following research questions:*(1) Are there any differences in incubation practices between business incubators in Brazil and Portugal? (2) How do the institutional environment and economic context affect the role of complementary assets on the performance of business incubators in both countries?*

Our main goal is to investigate the role of complementary assets in the success of business incubators through the performance of graduated firms nurtured with these complementary assets during the incubation process, comparing and assessing differences between Brazilian and Portuguese business incubators' practices. Our sample comprises 109 Brazilian and 52 Portuguese business incubators. The respondents are directors and managers of these incubators.

This study contributes to the literature by highlighting the factors distinguishing Brazilian and Portuguese business incubators' success, considering the countries' diverse institutional contexts. Furthermore, we uncover the role of complementary assets on business incubators' performance and

contribute to inform founders and managers of newly founded businesses and incubators by providing evidence of which attributes "make the difference" in the incubation process.

The paper has five sections. After this introduction, the Theory Review section presents the importance of complementary assets in business incubation, followed by a discussion on assessing the effectiveness of incubation through performance measures, and we finish this section with the characteristics of both countries' incubators and the presentation of our conceptual model. The third section describes the method, including data and variables. The fourth section presents the results, which are followed by a broad discussion of the antecedents of business incubators' success, comparing Brazilian and Portuguese business incubators. The last section is devoted to the results discussion, contributions, limitations and suggestions for future research.

4.2 Theory review

4.2.1 Business incubation

Business incubators are organizations that support entrepreneurship and business creation, promoting economic and social development, and fostering innovativeness (Bøllingtoft & Ulhøi, 2005; McAdam & McAdam, 2008; Schwartz & Hornych, 2008). Al-Mubaraki and Busler (2013) conducted a qualitative study that included ten multi-case studies in different countries and showed that countries with BIs can play a central role in economic development according to their growth and the number of graduated firms. Thus, BIs are popular tools to accelerate the creation of successful entrepreneurial companies (Ratinho, 2011). The main goal of incubators is to produce successful businesses by increasing their survival chances and offering a supportive environment that addresses their specific needs and challenges (Aernoudt, 2004; Torun et al., 2018). Most studies agree that incubation, the process of nurturing young ventures inside a BI, refers to a structured program designed to hatch and assist early-stage businesses in their development and growth (Albort-Morant & Ribeiro-Soriano, 2016; Salazar, 2020; Theodorakopoulos et al., 2014). Over the years, the incubation process evolved from a simple structure offering shared spaces and professional services to enhance the survival of new firms to a multifaceted organization providing access to technological, professional, and financial coaching, mentoring, and networking involvement through the access to external resources, knowledge, and legitimacy. Besides enhancing survival, the business incubation role is , to strengthen new firms to grow and achieve performance after the incubation period. Some authors recognize three generations of business incubators (*e.g.*, Bruneel et al., 2012; Theodorakopoulos et al., 2014), which are reported in Table 4.1, along with complementar information.

Table 4.1. Generations of business incubators

	Characteristics	Complementary assets provided	Type of complementary assets	Dimension
1st generation	» Shared office spaces » Shared laboratories » Low-cost infrastructure»	Infrastructure	Generic	Internal
2nd generation	» Coaching and mentoring support » Counseling in management issues » Formalize routines and roles	Formalization	Specialized	External
3rd generation	» Access to technological, professional and financial networks » Access to clients and suppliers » Access to collaborative research and coopetition	Legitimation	Specialized	External

Source: own elaboration

Within the incubation phase, tenant firms can benefit themselves from cost-efficient, highly specialized services, and access to essential resources (Theodorakopoulos et al., 2014). These resources encompass physical infrastructure, such as dedicated workspace, shared equipment, laboratories, and comprehensive administrative and logistical support (Apa, Gradinetti, & Sedita, 2017; Schwartz, 2013). Additionally, BIs are conduits for fostering crucial networking connections and facilitating the access to essential venture capital (Apa et al., 2017; Hackett & Dilts, 2004; Bergek & Norrman, 2008).

In a broader context, by providing new ventures the access to or aiding in acquiring specific assets, incubators offer an indispensable service to the firms under their mentoring (Bala Subrahmanya, Satyanarayana, & Chandrashekar, 2019). In effect, they promote and catalyze the performance of these incubated tenants, mitigating potential challenges associated with their early-stage liabilities and modest scale, characteristics frequently attributed to newly established and small-sized firms (Aldrich & Auster, 1986; Ferguson & Olofsson, 2004; Stinchcombe, 1965). These assets can be classified as complementary assets, which encompass the needed resources and capabilities for a business to strive and succeed (Reyes-Rodríguez & Ulhøi, 2022; Teece, 1986).

Newly founded firms face a discrepancy between critical resources necessary for their viability and their available resource base, factors that affect the likelihood of failure (Breivik-Meyer, Arntzen-Nordqvist, & Alsos, 2019). New firms do not have access to information and networks with potential customers and suppliers. Yet, they lack the expertise required to complete new product and process development or do not have access to expensive equipment, funding and skilled employees. Additionally, new firms must learn specific roles and tasks and must develop routines involving considerable resource

expenditure (Aldrich & Auster, 1986; Apa et al., 2017; Breivik-Meyer et al., 2019; Stinchcombe, 1965). Due to a reputation still under construction, new companies need help to gain legitimacy through the value chain, which is easily attainable during incubation. (Apa et al., 2017; Breivik-Meyer et al., 2019).

Business incubation takes place along three main dimensions: infrastructure, business support, and access to networks (Hackett & Dilts, 2004). Extant literature has explored some factors provided by incubation, which contribute to tenants' success. These factors can be classified as internal or external. Internal factors are linked to shared, low-cost offices, laboratory infrastructure, the human capital of entrepreneurs, and their experience in utilizing and developing resources and routines, such as management systems, production processes, and assembling effective teams (Breivik-Meyer et al., 2019; Liow & Wong, 2021). External factors are linked to building the bridge to create ties and trust with other stakeholders like suppliers, customers, or, at a larger scale, government agencies (Apa et al., 2017; Reyes-Rodríguez & Ulhøi, 2022). They are important to overcome problems coming from the lack of legitimacy, expressed through the scarcity of credit, lack of perceived legitimacy by suppliers and consumers, and entry barriers to the market (Breivik-Meyer et al., 2019; Reyes-Rodríguez & Ulhøi, 2022).

4.2.2 Measures of incubator performance

Since the main goal of business incubators is to promote a positive progression of the firms hosted within them (Hannon, 2005; McAdam & Marlow, 2007), the most straightforward metric to measure their success would be the frequency with which their incubatees graduate and thrive in the competitive market (Gurgel, Vieira, & Rodrigues, 2017; Vanderstraeten *et al*., 2016). Notably, within academic literature, the definition of incubator success remains multifaceted and subject to divergence of perspectives with no consensus regarding which metrics or factors exert the greatest influence on incubators performance (Dee, Livesey, Gill, & Minshall, 2011; Theodorakopoulos et al., 2014; UKBI, 2012).

Some studies lean toward using incubatee survival and growth as key performance indicators for evaluating incubation success, primarily due to the pivotal role of new firms in job creation and income generation (Aerts, Matthyssens, & Vandenbempt, 2007; Chan & Lau, 2005; Rathore & Agrawal, 2021; Wu et al., 2020). Several studies have explored innovativeness and technology creation as success measures. For instance, Binsawad, Sohaib, and Hawryskiewcz (2019) emphasize knowledge and innovation-sharing practices, along with patent registration, as pivotal gauges of incubation success, with a particular focus on regional development (Wang, He, Xia, Sarpong, Xiong, & Maas, 2020). Others have argued that a successful incubation journey is marked by events such as an initial public offering

(IPO), or a significant acquisition or merger (Avnimelech, Schwartz, & Bar-El, 2007; Gimmon & Levie, 2021). To comprehensively address these various success dimensions, previous studies have proposed a set of indicators based on strategic maps and performance dashboards, according to the premises of the Balanced Scorecard (BSC) and use it as a performance measurement tool for assessing incubators' performance (Shehada, El Talla, Al Shobaki, & Abu-Naser, 2020; Souza, Dantas, El Aouar, & Silva Barreto, 2015).

Given their embeddedness within a broader entrepreneurial ecosystem, stakeholder theory has been frequently applied to the analysis. Through their operations, incubators engage with diverse stakeholders, prompting investigations into the value creation for these vested interests (Nicholls-Nixon & Valliere, 2020). Some studies adopted a comprehensive perspective, encompassing citizens and policymakers (McAdam & Keogh, 2006; Santos, 2022), while others adopt a more restricted view, focusing exclusively on the main stakeholders (Liow & Wong, 2021; Ratinho & Henriques, 2010). In this study, we follow Vanderstraeten et al. (2016) and consider the survival rate of graduated firms three years after leaving the incubator. This measure includes economic, managerial, and social aspects, and it considers the primary objective of the incubator, that is, the survival of its former tenants.

Business incubators constitute pivotal institutional structures that play a central role in facilitating and nurturing entrepreneurial endeavors, as underscored by extensive scholarly research (Clarysse, Wright, Bruneel, & Mahajan, 2014; Goswami, Mitchell, & Bhagavatula, 2018; Klofsten, Lundmark, Wennberg, & Bank, 2020; Pauwels, Clarysse, Wright, & van Hove, 2016; Rubin, Aas, & Stead, 2015; van Weele, van Rijnsoever, Eveleens, Steinz, van Stijn, & Groen, 2018). They serve as dynamic conduits, bridging the gap between their tenant firms and the external business environment, a function of vital significance (Bergek & Norrman, 2008). One of the paramount objectives of business incubation is the promotion of sustainability and positive progression of the firms hosted within them (Hannon, 2005; McAdam & Marlow, 2007).

Consequently, the most straightforward metric to gauge success in this context pertains to the frequency with which incubatees graduate from the incubator and subsequently thrive in the competitive market (Gurgel et al., 2017; Vanderstraeten et al., 2016). Nevertheless, scholars have embarked on a quest to establish a comprehensive set of indicators aimed at "illuminating the inner workings of the black box of business incubation" (Hackett & Dilts, 2008, p.440). Notably, within academic literature, the definition of incubator success remains multifaceted and subject to divergence of perspectives with no consensus regarding which metrics or factors exert the greatest influence on incubators performance (Dee et al., 2011; Theodorakopoulos et al., 2014; UKBI, 2012).

Furthermore, scholarship delves into the nature of services offered within incubators, scrutinizing their quality and extent. These services encompass the provisioning of physical infrastructure, encompassing office space and laboratories, the availability of shared logistical and administrative facilities, and active facilitation of business support and networking opportunities (Apa et al., 2017; Azadnia, Stephens, Ghadimi, & Onofrei, 2022; Breivik-Meyer et al., 2019; Caetano, 2022; Sedita et al., 2019). Despite the numerous criteria proposed for measuring incubator performance, the literature remains characterized by fragmentation and a lack of consensus, with the outcomes of incubator performance still shrouded in a certain degree of ambiguity and opaqueness (Wu et al., 2020).

4.2.3 Complementary assets and incubation process

Complementary assets represent vital resources and capabilities that can be physical, human, or organizational within a firm (Reyes-Rodríguez & Ulhøi, 2022; Teece, 1986). They play a crucial role in successfully realizing competitive advantages stemming from an innovation, a new product or process, or a new venture (Teece, 1986). These complementary assets can be broadly categorized into generic or specialized types. Generic complementary assets are not specifically designed, since they possess multiple applications and can be easily purchased in the open market (Arora & Ceccagnoli, 2006; Teece, 1986). For example, they are commonly used to organize various business units and facilitate the transfer of knowledge among them (Helfat & Lieberman, 2002).

In contrast, specialized complementary assets constitute valuable, unique, and challenging-to-replicate resources that confer a distinct competitive advantage (Barney, 1991). They are intricately linked to the incubation process and are often challenging to be obtained in the market due to their tailored use in specific contexts and prolonged development cycles (Helfat & Lieberman, 2002; Teece, 1986). Competitive advantage is notably bolstered when firms control specialized complementary assets that are indispensable for appropriating the benefits derived from an innovation (Sköld, Freij, & Frishammar, 2020; Teece, 1986). Studies have identified such specialized complementary assets in various forms, including downstream assets, such as commercialization and marketing capabilities (Ceccagnoli & Hicks, 2013; Chiu, Lai, Lee, & Liaw, 2008), regulatory management (Rothaermel & Hill, 2005), and upstream complementary assets, like component technology and production capabilities (Chiu et al., 2008; Reyes-Rodríguez & Ulhøi, 2022).

Complementary assets coming from the incubation process include a range of resources. For instance, among generic complementary assets, we can identify elements like office infrastructure, reception services, as well as manufacturing spaces (Carayannis & von Zedtwitz, 2005; Soetanto & Jack,

2013; Soetanto & Klofsten, 2021). On the other hand, specialized complementary assets encompass domains such as marketing and distribution networks, marketing and sales capabilities (Rothaermel & Hill, 2005), mentorship, post-sales servicing (Ceccagnoli & Hicks, 2013; Chiu et al., 2008; Paradkar, Knight, & Hansen, 2015), workforce organization and training (Bresnahan, Brynjolfsson, & Hitt, 2002), and assets such as brand value, reputation, customer and supplier networks, and specialized technology (Bresnahan et al., 2002; Helfat & Lieberman, 2002; Paradkar et al., 2015).

New firms demand complementary assets for many reasons. First and foremost, nascent companies often need financial resources to secure or create complementary assets that require substantial capital investment (Nicholls-Nixon et al., 2022). Initial managerial challenges, such as integration into the supply chain (Schwartz, 2013; Stinchcombe, 1965), team commitment (Apa et al., 2017; Chorev & Anderson, 2006), and variations in the competencies and skills of the management team (Aspelund, Berg-Utby, & Skjevdal, 2005), can be obstacles to their survival and growth. Second, acquiring or developing complementary assets typically involves a protracted timeframe, an impractical scenario for most emerging businesses (Ramírez-Alesón & Fernández-Olmos, 2018). Third, competitors may already possess such assets or be better positioned to develop them (Apa et al., 2017; Hughes, Ireland, & Morgan, 2007).

Newly established firms are inherently tempted to start their operations within BIs, primarily driven by the need to gain access to complementary assets, thereby mitigating the inherent challenges associated with their early-stage vulnerabilities (Fukugawa, 2018; Ramírez-Alesoón & Fernández-Olmos, 2018). This, in turn, strengthens the firm's reputation and legitimacy. Previous research highlighted that by supplying complementary assets, incubators foster relationships with various stakeholders and are significantly correlated with survival and growth, particularly in the context of innovations and new product development. As a result, it establishes a path dependency, enabling continued firm fortification even after the incubation phase (Hughes et al., 2007; Fernández-Alles, Camelo-Ordaz, & Franco-Leal, 2015; Khodaei et al., 2022; Rothaermel, 2001; Sköld et al., 2020).

Therefore, BIs improve their tenants along four dimensions: (1) credibility and legitimacy development; (2) reduction of the learning curve, saving time and resources, and providing a formalization of processes, contracts, and managerial roles; (3) quicker solutions of problems and (4) access to networks, alliances and shared subsidized infrastructure (Caetano, 2022; Fukugawa, 2018; Nicholls-Nixon et al., 2022; Khodaei et al., 2022). These benefits contribute to get complementary assets. This contribution aims to help entrepreneurs to fight the main threats they face throughout the development of new firms and strengthen companies for survival and growth after graduation at the end

of the incubation period. Thereby, we can predict that complementary assets provided during the hatching period strengthen graduated firms, increasing survival likelihood.

In this study, we use the complementary asset view to assess the antecedents of business incubators performance through the survival rate of graduated firms. The conceptual model adopted is shown in Figure 4.1. The complementary assets provided during incubation can be divided into infrastructure facilities, formalization of operational processes and routines, and legitimation among stakeholders. These services offered by the business incubator strengthen tenants' survival likelihood by neutralizing typical threats new ventures face, and extending the higher survival likelihood after the incubation period. We assert that the survival of graduated firms determines business incubation performance.

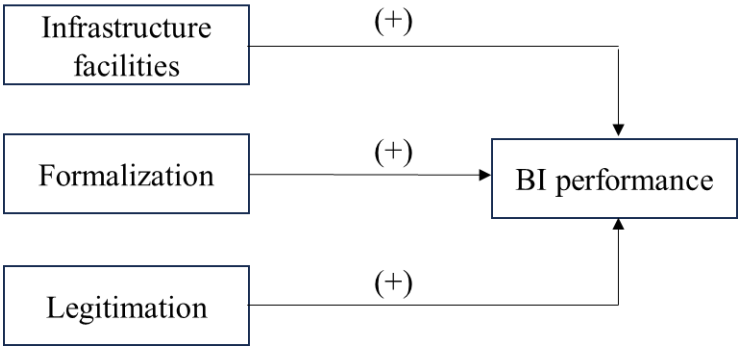


Figure 4.1. Conceptual model
Source: own elaboration

4.3 Methodological framework

4.3.1 Data collection and sample

We use primary and secondary data collected from various sources. For Brazilian incubators, we use the SAPI database that provides information on business incubators and science parks and is part of the "Innovation" portal of the Brazilian Ministry of Science and Culture (portalinovacao.mct.gov.br). This database brings information about incubators, and graduated firms' survival. Additional data from the websites of each incubator were also collected, such as provided services and infrastructure facilities offered. Finally, we contacted incubator managers by phone or e-mail to solve persisting doubts. Data collection took place between May and June of 2020. Of the 129 incubators included in the SAPI database, we excluded those that did not have at least one of the variables of interest in our

study, basically occupation rate or data about graduated firms (20 incubators). The final sample comprises 109 incubators spread over all Brazilian states, bringing an expected variance for our research.

For the Portuguese incubators, we collected data of the business incubators through a survey instrument designed with the collaboration of incubators' directors and managers specifically for this research. The survey instrument is available in Appendix 1. We sent the survey to the incubators listed on the Startup Portugal website (startupportugal.com) in the National Incubator Network. We received 52 valid responses between May 2022 and April 2023. We collected information from incubators from all regions of the mainland and insular regions of Madeira and Azores.

The focus of the data collection of the business incubators in both countries was to identify the types of services related to complementary assets provided by the incubators, which were divided into three main categories: physical infrastructure, legitimacy, and formalization. Later, we divided these complementary assets into generic and specialized ones to proceed with the analyses.

4.3.2 Variables

Business incubators' performance

The business incubators' performance is obtained by assessing the performance of firms that have successfully graduated from the incubation program. It is employed to gauge the effectiveness of the incubator since it reflects the core role played by the incubator. We chose this approach for two reasons. First, our research centers on the interplay between the incubator and the firms that have completed the incubation cycle. It examines the support and resources provided to these firms during incubation period and how they apply the competencies and capabilities they developed through the access to complementary assets (Sydow, Schreyögg, & Koch, 2009). Thus, our focus is directed toward each incubator's specific types of complementary assets. Secondly, the performance of an incubator is intricately intertwined with the success and performance of the companies that have undergone its incubation program (Mas-Verdú, Ribeiro-Soriano, & Roig-Tierno, 2015). The incubator's efficacy is deeply influenced by the outcomes achieved by the firms it has nurtured, emphasizing the symbiotic relationship between the incubator and the graduated firms.

We calculated this variable by collecting the number of graduated firms and how many remain active after three years. This ratio is considered a standard indicator for measuring the efficiency of an incubator (Aerts et al., 2007; Ferguson & Olofsson, 2004; M'Chirgui, Lamine, Mian, & Fayolle, 2018; Torun et al., 2018; Vanderstraeten et al., 2016). We extracted this data from the SAPI portal for Brazilian incubators and the completed forms from Portuguese incubators.

Complementary assets

We categorized incubators' complementary assets into three distinct groups: infrastructure, formalization, and legitimation (Table 4.2). These three categories encompass the essential tangible and intangible components inherent to the incubation process, as described in the extant literature (*e.g*., Ahmad & Thornberry, 2018; Allen & McCluskey, 1991; Azadnia et al., 2022; Bruneel et al., 2012; De Oliveira & Terence, 2018; Hackett & Dilts, 2004; Theodorakopoulos et al., 2014; Torun et al., 2018). These groups align with prior research that has examined the services rendered during the incubation process (*e.g*., Galiyeva & Fuschi, 2018; Mian, Lamine, & Fayolle, 2016; Pauwels et al., 2016; Soetanto & Jack, 2013). Table 4.2 presents the variables related to each type of complementary asset, how they are referred to, and the source where they are used and extracted to this study.

Within the infrastructure group, we find assets associated with subsidized and shared facilities, encompassing office space and associated services (*e.g.* reception, meeting rooms), parking amenities, laboratories, and operational equipment. According to Ratinho (2011), scale and scope economies surrounding infrastructure provision are responsible for the cost reduction to tenants and have several other advantages to tenants. The formalization group encompasses coaching, mentoring, counseling, management, and trade-oriented training. The legitimacy group, in turn, encompasses activities that foster, reinforce, and promote networking and establish a favorable reputation among clients, suppliers, credit agencies, and development entities.

When we delve into the realm of complementary assets, we recognize that the benefits provided by an incubator are associated with subsidized and shared infrastructure facilities primarily align with the category of generic complementary assets. As such, these offerings are more likely to be widely available and do not necessarily confer a distinctive strategic advantage. Conversely, aspects related to the formalization of operational procedures and the cultivation of reputation and legitimacy, which contribute to effective networking and facilitate market integration, are considered critical drivers of success within the incubation process (McAdam & McAdam, 2008) and fall under the specialized complementary asset category.

The scores and the predominance of aspects linked to infrastructure, formalization, or legitimacy supported by the BIs were identified through our sample. The computation of the scores of these three variables (infrastructure, formalization, and legitimation) is based on counting the attributes of these variables identified in the sample. The predominance is expressed as a ratio between the specific group and all the supported benefits. The predominance of the variable is associated with its relative frequency compared to the other variables.

As our data from Brazilian incubators were gathered from secondary sources, we conducted a robustness test by collecting the same information directly from the incubators. For this purpose, we adopted the same instrument used to collect information from the Portuguese sample, with questions regarding the services provided during incubation and the survival of the graduated firms. We sent it to all the 109 business incubators of our sample, and we received 34 forms back, obtaining a 27.5% rate of return. Missing data analysis indicated that four cases missed 60% or more of the variables referring to the graduated firms. We excluded these four forms to avoid an artificial increase in the relationships between the variables (Hair, Black, Babin, & Anderson, 2019). Thus, the final sample for the robustness check comprised 30 incubators. A paired-sample t-test confirms that no significant differences exist between the distribution of the measures provided by the Brazilian incubator managers through our form and those of the incubators' websites. Therefore, we kept our primary sample of 109 Brazilian incubators to proceed with this research.

Table 4.2. Complementary assets

Complementary assets category	**Collected variables**	**Source**
Infrastructure	Office (physical space)	Bruneel *et al*. (2012)
	Office services (reception, equipment, connection)	Bruneel *et al*. (2012)
	Parking	von Zedtwitz & Grimaldi (2006)
	Production equipment	Bruneel *et al*. (2012)
	Laboratories	von Zedtwitz & Grimaldi (2006)
Formalization	Coaching	Theodorakopoulos *et al*. (2014)
	Mentoring	Theodorakopoulos *et al*. (2014)
	Business consulting (management, marketing)	Chan & Lau (2005)
	Training in management	Ratinho & Henriques (2010)
	Commercial training	Wann *et al.* (2017)
Legitimation	External professional services (patents, accounting, consultancies)	Theodorakopoulos et al. (2014)
	Access to financial agents (angel investors, banks, development agencies)	Bruneel *et al*. (2012)
	Access to the supplier network	Soetanto & Jack (2013)
	Access to the customer network	Soetanto & Jack (2013)
	Access to shows and trade fairs	Chan & Lau (2005)

Source: own elaboration

4.3.3 Data analysis

Two approaches were used for sample treatment and data analysis: (1) cluster analysis to separate business incubators into groups with similar characteristics, considering their performance, adopting

hierarchical and non-hierarchical techniques, and (2) comparison of groups adopting two non-parametrical tests, Kruskal-Wallis, and Mann-Whitney U-test. As the variables under analysis in each group do not follow the Normal distribution, we used non-parametric tests for comparison. In both tests, the null hypothesis expresses equality between the values, while the alternative hypothesis states that the values are not equal. All these analyses were performed using the IBM SPSS Statistics version 26.

4.4 Results

4.4.1 Cluster analysis

The objective of taking over a cluster analysis is to assess whether there is similar behavior within each group of incubators (Brazilian and Portuguese) concerning the complementary assets and performance. To this end, we conducted a cluster analysis to split the two samples into homogenous groups of incubators, using performance as the main driver. The two samples are composed of 109 Brazilian incubators and 52 Portuguese incubators. A two-stage clustering process was applied to generate and assess the number of clusters (Everitt, Landau, Leese, & Stahl, 2011). Firstly, a hierarchical cluster analysis was conducted using the squared Euclidean distance as a similarity measure and Ward's method as an agglomerative algorithm (Everitt et al., 2011). The number of clusters was chosen based on the dendrogram, R-squared statistic, and Mojena factor (Mojena, 1977). The criteria for determining the number of clusters indicated a 3-cluster solution for each sample because their centroids differed significantly. Furthermore, after analyzing the obtained results, this solution regarding clusters' profiles proved adequate regarding the clusters' interpretation and significance. Secondly, a nonhierarchical K-means clustering technique for a definitive classification of cluster membership for each incubator was used and proceeded for both samples. The three clusters were labeled in terms of the performance measures. Cluster 1, labeled as "Average," comprises 66% of the incubators in the Brazilian sample and 25% of the incubators in the Portuguese sample. Cluster 2, named "Best," comprises 22% and 31% of the incubators in the Brazilian and Portuguese samples, respectively. Finally, cluster 3, "Worst," comprises 12% and 44% of incubators in the Brazilian and Portuguese samples, respectively (Table 4.3 and Figure 4.2). Group differences were assessed using Kruskal-Walli's test to evaluate the profile of the identified clusters in terms of the interest variables (performance measures).

Table 4.3. Clusters

	Incubators	
Clusters	**Brazilian**	**Portuguese**
1 - Average	66%	25%
2 – Best	22%	31%
3 – Worst	12%	44%

Source: SPSS

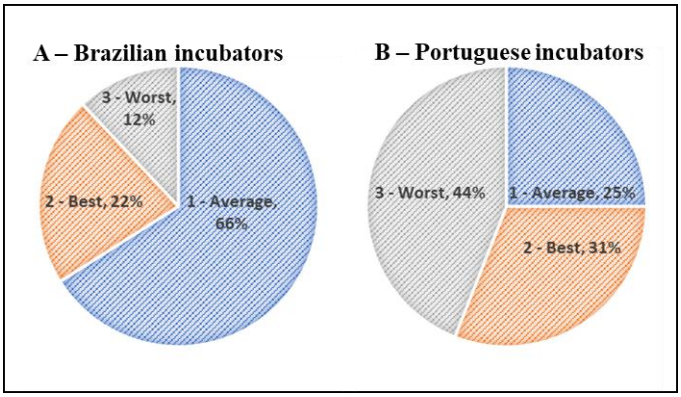


Figure 4.2. Clusters
Source: MS Excel

4.4.2 Groups profile comparison

Table 4.4 reports the profile of each cluster, regarding the absolute frequency of each complementary asset offered, calculated by counting the services provided within each category of complementary asset, as well as the relative frequency, accounted by the ratio of services offered under each category of complementary assets over the others. It also reports the p-values corresponding to the Kruskal-Wallis test to the means comparison.

We can note that there is no evidence of statistically significant differences in the average number of infrastructure services (p = 0.167) and the average value of the occupancy rate (p = 0.110) among the clusters with Brazilian incubators. These results seem to suggest the provision of infrastructure services and the occupation rate could not be a criterion considered when choosing a particular incubator, either due to a lack of a more profound knowledge of which other services are offered during incubation or due to some intrinsic attraction, for example, geographical proximity to raw material sources, or similar companies. On the contrary, there is evidence of statistically significant differences between the clusters' performance (p = 0.046), in accordance with the cluster separation criterion. In addition, our results show statistically significant differences in the average formalization and legitimation services and in their predominance among the clusters. This appears to be a competitive advantage for business incubators,

except for the predominance of infrastructure services, in which cluster 3, containing the worst-performing incubators, has the highest average.

The results for the Portuguese incubators' clusters also suggest no evidence of statistically significant differences in the occupancy rate (p = 0.692), just like among the Brazilian clusters. But contrarily to the results for the Brazilian clusters, there is evidence of statistically significant differences in the average number of infrastructure services (p = 0.000). It is worth noting that the infrastructure and the occupation rate are known as incubators' competitive advantages because these characteristics are easily noticed and are sometimes used by incubators as attraction factors for new firms. However, according to our results, the occupation rate does not seem to be a competitive advantage in both universes, whereas the infrastructure services seem to be a distinctive feature among Portuguese groups. Similar to the Brazilian clusters, the complementary assets provided, the formalization services and the legitimation services seem to be distinctive features, as results report evidence of statistically significant differences among the clusters. However, contrarily to what is reported for the Brazilian clusters, there is no evidence of statistically significant differences among the Portuguese clusters in what concerns to the predominance of infrastructure services, specialized complementary assets and formalization services.

It is also worth noting that the clusters that make up the sample of Brazilian incubators are similar in providing infrastructure services, which can be considered a minimum requirement in hosting a firm and, therefore, a generic complementary asset, a fact not confirmed among the Portuguese incubators, perhaps indicating a symptom of institutional differences between the two countries. A particularity observed in the sample of Portuguese incubators resides in the non-significant difference in the predominance of services related to the set of specialized assets (p = 0.174) but only statistically significant for aspects of legitimacy (p = 0.015), a fact that is repeated among the Brazilian incubators (p = 0.000) and confirms previous studies that point to the relevance of this characteristic in the incubation process (Chen, Qian, & Narayanan, 2017; Nicholls-Nixon et al., 2022; Fukugawa, 2018; Khodaei et al., 2022).

Table 4.4. Cluster profile and comparison within sample

Brazilian Incubators	**Cluster 1 Means**	**Cluster 2 Means**	**Cluster 3 Means**	***p*-values (Kruskal-Wallis test)**
Performance	81.9%	94.7%	77.2%	0.046
Complementary assets provided	8.1	10.3	5.4	0.000
Infrastructure services	3.4	3.5	3.1	0.167
Formalization services	2.7	2.6	1.2	0.000
Legitimation services	2.3	4.1	1.8	0.000
Predominance of infrastructure services	43.0%	35.0%	57.0%	0.000
Predominance of specialized compl. assets	57.0%	65.0%	43.0%	0.000
Predominance of formalization services	33.0%	26.0%	23.0%	0.000
Predominance of legitimation services	24.0%	39.0%	20.0%	0.000
Occupation rate	69.0%	79.9%	72.0%	0.110
Cluster size (n)	72	24	13	
Cluster profile	Average	best	worst	
Portuguese incubators				
Performance	90.8%	91.3%	80.5.0%	0.037
Complementary assets provided	5.0	12.0	9.0	0.000
Infrastructure services	2.0	4.0	3.0	0.000
Formalization services	2.0	5.0	3.0	0.000
Legitimation services	1.0	4.0	3.0	0.000
Predominance of infrastructure services	38.0%	31.0%	32.0%	0.175
Predominance of specialized compl. assets	62.0%	69.0%	68.0%	0.174
Predominance of formalization services	36.0%	37.0%	33.0%	0.411
Predominance of legitimation services	26.0%	32.0%	35.0%	0.015
Occupation rate	78.0%	81.0%	77.0%	0.692
Cluster size (n)	13	16	23	
Cluster profile	average	best	worst	

Source: SPSS

As we intend to assess the differences between the characteristics of Brazilian and Portuguese business incubators, we compared equivalent clusters formed by Brazilian and Portuguese incubators according to their profile. We tested the existence of differences in the selected variables for each cluster profile between Brazilian and Portuguese incubators, by using the Mann-Whitney U-test. The results are reported in Table 4.5.

In general, there is no evidence of statistically significant differences between Brazilian and Portuguese incubators' performance in cluster 1. However, the disaggregated analysis uncovers relevant results. There is evidence of statistically significant differences in the count variables (absolute values), in the complementary assets provided, infrastructure services, formalization services, and legitimization services, in favor of the Brazilian incubators. On the other hand, no statistical differences were found between Brazilian and Portuguese incubators in terms of the variables that express relative values of a given service compared to the others. The differences are not significant, thus maintaining the null hypothesis. The predominance of service over the others is a relevant comparison, as it identifies how much that service stands out during the incubation process.

Cluster 2 presents a statistically significant difference in performance in favor of Brazilian incubators. There is evidence of statistically significant differences in the count variables (absolute values), that is, in complementary assets provided and formalization services, in favor of the Portuguese incubators, which indicates that, on average, the Portuguese incubators provide more variety of services. Furthermore, no statistical differences were found between Brazilian and Portuguese incubators regarding the variables that express relative values of infrastructure services and specialized complementary assets. On the other hand, we found a statistically significant difference in the predominance of formalization and legitimation services favoring Portuguese and Brazilian incubators, respectively. Notably, both sets of services represent specialized assets and, owing to their inherent characteristics, can bestow competitive advantages upon the firms that avail themselves of these services. Consequently, in these comparative analyses, we must reject the null hypothesis.

Cluster 3, evaluated as the worst-performing incubator cluster, presents higher and more significant averages for the Portuguese incubators in the variables associated with the services related to formalization and legitimation and for the Brazilian ones regarding infrastructure provision, both in absolute and relative values.

Table 4.5. Mann-Whitney U-Test between samples

	Cluster 1- Br	Cluster 1- Pt	Mann-Whitney U-test	p-value
Performance	81.9%	90.8%	442.000	0.740
Complementary assets provided	8.1	5.0	0.000	0.000
Infrastructure services	3.4	1.9	105.000	0.000
Formalization services	2.7	1.8	200.000	0.000
Legitimation services	2.3	1.3	180.500	0.000
Predominance of infrastructure services	43%	38%	446.500	0.790
Predominance of specialized compl. assets	57%	62%	446.500	0.790
Predominance of formalization services	33%	36%	443.000	0.756
Predominance of legitimation services	24%	26%	459.000	0.911
Occupation rate	69%	78%	350.500	0.151
	Cluster 2- Br	**Cluster 2- Pt**		
Performance	94.7%	91.3%	73.500	0.001
Complementary assets provided	10.3	12.1	31.000	0.000
Infrastructure services	3.5	3.8	155.500	0.318
Formalization services	2.6	4.5	30.000	0.000
Legitimation services	4.1	3.9	161.000	0.404
Predominance of infrastructure services	35%	31%	131.000	0.095
Predominance of specialized compl. assets	65%	69%	131.000	0.098
Predominance of formalization services	26%	37%	51.000	0.000
Predominance of legitimation services	39%	32%	96.000	0.007
Occupation rate	80%	81%	183.500	0.817
	Cluster 3- Br	**Cluster 3- Pt**		
Performance	77.2%	80.5%	102.500	0.123
Complementary assets provided	5.4	9.0	2.000	0.000
Infrastructure services	3.1	3.1	145.500	0.897
Formalization services	1.2	3.0	21.500	0.000
Legitimation services	1.8	3.0	69.500	0.007
Predominance of infrastructure services	57%	32%	18.000	0.000
Predominance of specialized compl. assets	43%	68%	18.000	0.000
Predominance of formalization services	23%	33%	35.500	0.000
Predominance of legitimation services	20%	35%	40.500	0.001
Occupation rate	72%	77%	110.000	0.478

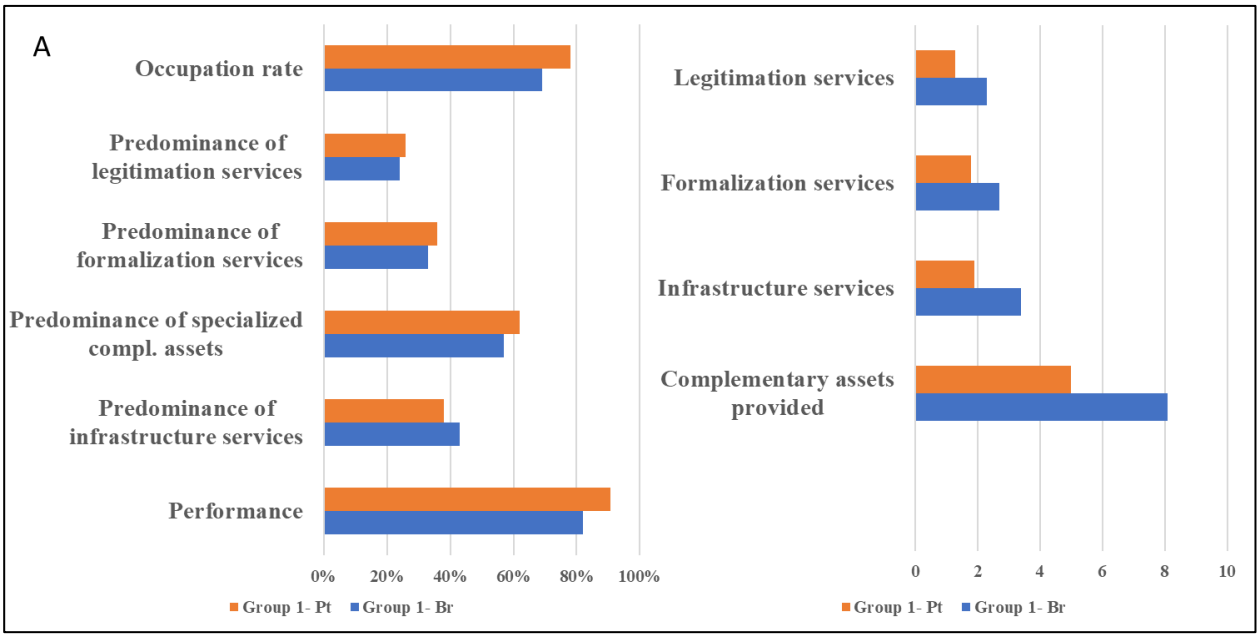
Note. Shaded values refer to significant characteristics between clusters.
Source: SPSS

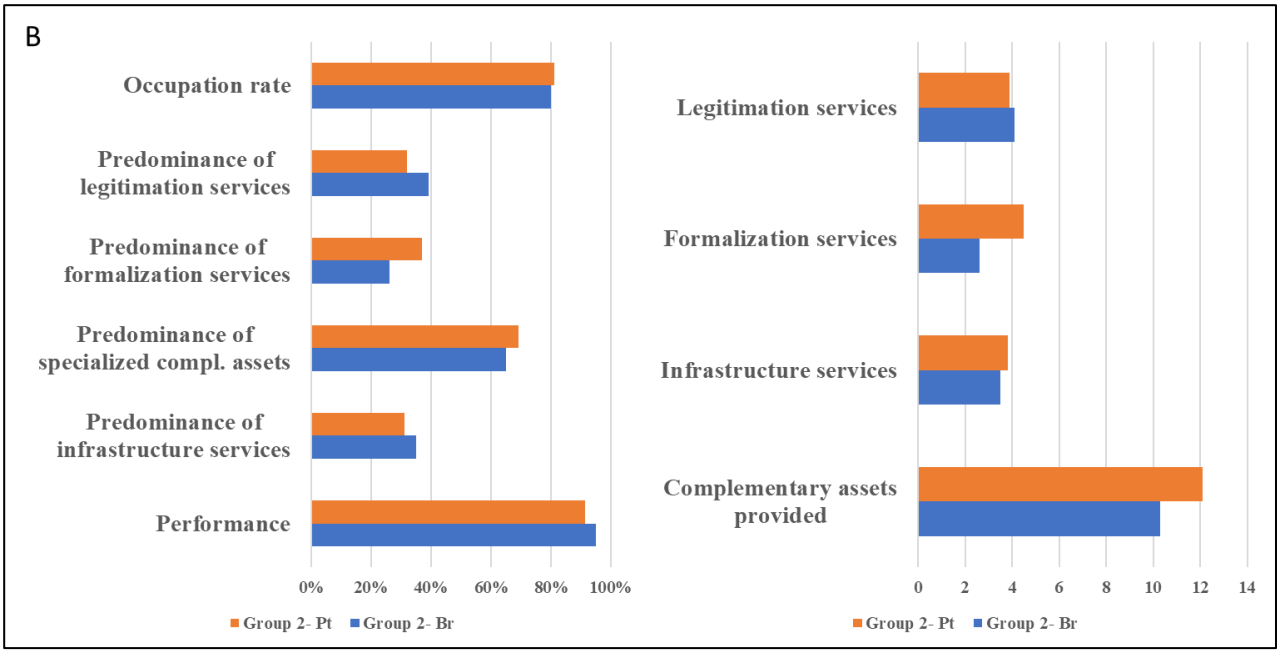
Figure 4.3 summarizes the characteristics of each cluster. It shows no evidence of a difference between Brazilian and Portuguese incubators in terms of average occupancy rate. Further, it also highlights the predominance of specialized complementary assets, formalization, and legitimation services offered by the Portuguese incubators and the infrastructure and legitimation services for the

Brazilian ones. The facilities regarding public services and regulatory quality appear to be a disadvantage in the Brazilian institutional profile (Kaufman & Kraay, 2023). These weaknesses in the Brazilian institutional context suggest a greater necessity for providing infrastructure services and greater efforts for legitimation among stakeholders and innovation protection, for example.

On the other hand, Portuguese incubated teams need training and coaching in management processes, once there is sufficient government effectiveness compared with Brazil. However, legitimation issues are also relevant for strengthening new firms in both countries. It is worth noting that the absolute value of complementary assets provided, taken by counting the amount and variety of services offered, is higher for the Portuguese incubators in the three clusters. This may indicate that the hatching process in the Portuguese incubators is generally more complete. Business incubators evolved from the 1980 decade offering just infrastructure facilities to provide coaching, mentoring, and networking (Theodorakopoulos et al., 2014). Our findings suggest that Portuguese incubators are in an higher development stage relatively to the Brazilian incubators.

We employed two sources to assess Brazil's and Portugal's institutional profiles: (1) IPD, Institutional Profiles Database, from the French Ministry for the Economy and Finance (IPD, 2016), and (2) WGI, Worldwide Governance Indicators (Kaufmann & Kraay, 2023).





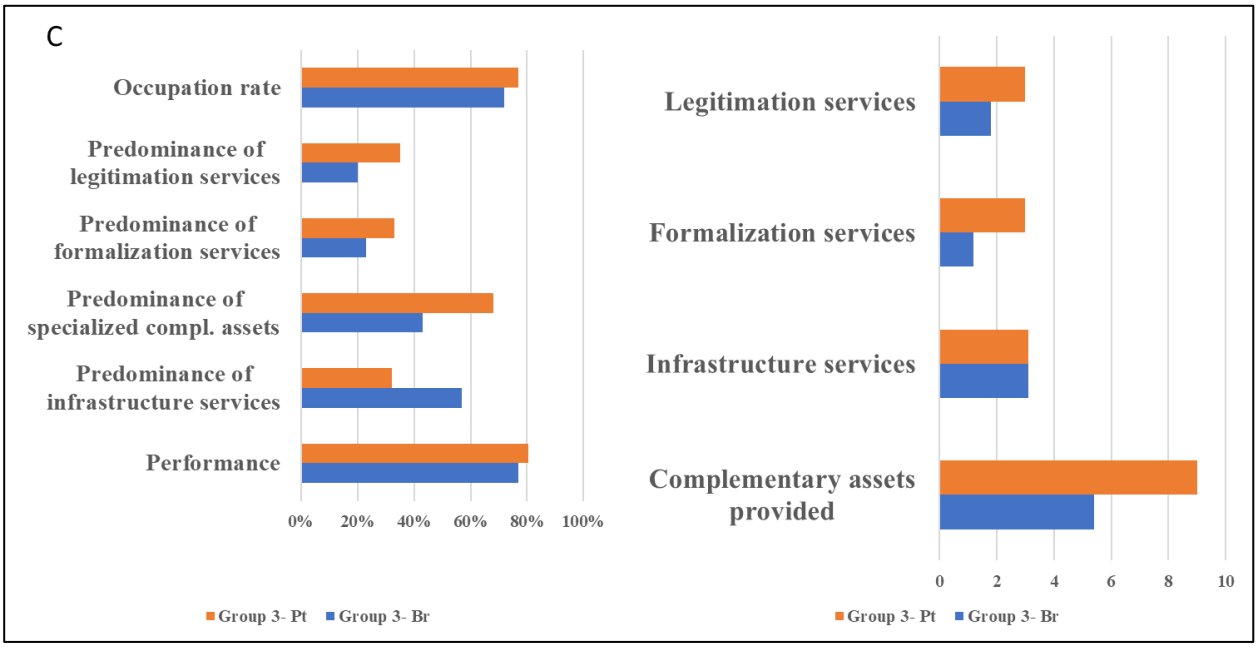


Figure 4.3. Comparisons within groups – A: Cluster 1 – B: Cluster 2 – C: Cluster 3
Source: MS Excel

4.5 Discussion, contributions, limitations, and future research

4.5.1 Discussion

Comparative studies between Portuguese and Brazilian business incubators may not point out fundamental differences for several reasons. Portugal and Brazil share a common language and have

similar historical, cultural, and business ties. The shared cultural and linguistic background could lead to similarities in business practices, incubator models, and approaches to entrepreneurship. Moreover, incubators in both countries might be influenced by global best practices in entrepreneurship, innovation, and incubation, leading to similar approaches and strategies. These best practices usually refer to incubators' networks, knowledge-sharing platforms, and advanced mentorship and coaching support.

It is important to note that even if the studies did not reveal substantial differences, they might exist since incubators are influenced by a combination of local, cultural, economic, and institutional factors. We proposed investigating variations between incubation practices in Portugal and Brazil using the lenses of the complementary assets view (Teece, 1986). We argued that the mix of these assets determines the ex-tenant firms' survival and, consequently, the incubators' success.

In this study, we delved into the differences in the incubation process between the two countries, splitting the services provided into three categories: office infrastructure facilities, support for formalizing operational processes and routines and building legitimacy and reputation. We associated these incubation services with a complementary assets view, dividing them into generic and specialized assets. Also, we classified them in two categories, considering the scope in which they operate, i.e. internally or externally to the firm. Infrastructure has an internal characteristic to the incubated firm, as well as the formalization of processes, but with a higher level of specialization and a hybrid contextual characteristic between internal and external environments when it comes to formalizing processes and establishing managerial functions or when it is related to market analysis or launch definition of products. On the other hand, legitimacy is a specialized and inimitable complementary asset, as it is closely relatedto the company and is focused on its relations with the outside world, since it is basically about obtaining a reputation.

We found some differences between business incubators in Brazil and Portugal. The incubators were divided into three clusters, using performance as a grouping criterion. The conceptual model, with the different categories of complementary assets, reveals differences between business incubators due to the country and the cluster to which they belong. Overall, our findings point to a more intense infrastructure provision among the Brazilian business incubators, understood as an effort to compensate for institutional deficiencies, like high rents and a lack of facilities like shared spaces or public subsidized services for new firms. As Brazil has a large territory and important economic development differences among its regions, this lack of infrastructure is an average point expressed through the business incubators of our sample. Also, the emphasis on providing infrastructure is typical for the first generation of business incubators (Theodorakopoulos et al., 2014). This is not a competitive advantage for business

incubators in Portugal, as its small territory facilitates mobility within the country, leading to a search for an incubator that best matches the needs sought. Therefore, we observed that infrastructure services are average among Portuguese business incubators and cannot be regarded as a key driver of good performance.

Due to this fact, it is expected that aspects linked to the predominance of formalization and legitimation could be seen as drivers for Portuguese business incubators' success and are also characteristics of the second and third business incubators generations (Theodorakopoulos et al., 2014). In all three clusters, with the exception for the predominance of the legitimation services, in Cluster 2, these factors emerged as having the highest averages compared to the Brazilian incubators. The predominance of formalization and legitimation services accelerates the learning curve, strengthening the incubatee for future solo life. Services regarding legitimation, access to external resources, and networking development were also found with intensity among Brazilian business incubators.

Moreover, we can infer that tenants in the scale-up phase search for market expansion and internationalization is an option, particularly for Portuguese firms, due to Portugal's reduced market size and the facilities of being part of the European Economic Community (Carvalho & Galina, 2015). Legitimation and formalization bring essential capabilities to tenants that will be carried along after graduation. Our findings also pointed to the relevant frequency of services linked to legitimation among Brazilian business incubators. Figure 4.4 summarizes the overall differences in our comparison of the complementary assets offered by Brazilian and Portuguese business incubators, highlighting the kind of complementary asset where it is prevalent.

Antecedents of success	**Brazil**	**Portugal**
Complementary assets provided		
Infrastructure services		
Formalization services		
Legitimation services		
Predominance of infrastructure services		
Predominance of specialized compl. assets		
Predominance of formalization services		
Predominance of legitimation services		

Figure 4.4. Determinants of BIs success
Source: own elaboration

In summary, due to their different degrees of institutional development, Brazil and Portugal lead incubators to provide different services to incubated companies. The more homogeneous economic environment, the more mature and efficient institutions, and the geographic dimension of the country

lead Portuguese incubators to focus on providing, with greater intensity, services aimed at optimizing the internal processes of the incubated companies and, like the Brazilian ones, at legitimizing, that is, building a reputation with stakeholders. In addition, Brazilian incubators are making a more significant effort to supply incubated companies with services aimed at physical infrastructure at a subsidized cost. Thus, the incubation process in Portugal is more focused on offering specialized complementary assets that impact the incubated firms' internal aspects (for example, the formalization of operational procedures) and external aspects (for example, the search for legitimacy through insertion into the networking with stakeholders). In Brazil, aspects linked to the supply of generic complementary assets, such as infrastructure, are still important, but just like for the Portuguese business incubators, legitimacy is also a vector of success. Figure 4.5 summarizes the results of this study regarding the level of specialization of the complementary assets offered by Brazilian and Portuguese incubators and the impacted environment of the firm. Furthermore, we point out how this fact varies depending on the economic and institutional contexts of the two countries.

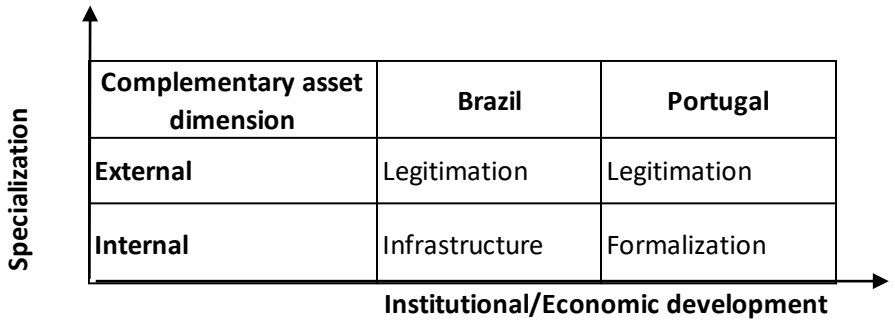


Figure 4.5. Services provided by Brazilian and Portuguese BIs.
Source: own elaboration

4.5.2 Contributions and limitations, and suggestions for future studies

This study brings contributions to academia and practice. For the theory, we contribute to deepening the discussion on complementary assets by investigating the success factors of a business incubator. We delved into the role of the complementary assets provided during the incubation process. We evaluated the role of each one of them within a model that divides the services provided in the incubation into infrastructure offers, formalization of routines, and the search for legitimacy in the business environment. We show their relevance for the companies' survival and, consequently, as

determining factors of the incubator's success. In addition, we contribute to increasing the business incubation literature that simultaneously addresses Brazil and Portugal.

For managers of incubators and incubated firms, this study can guide what to look for in an incubator or what services to offer to prepare the company after graduation. We also bring information for those entrepreneurs who intend to develop a company outside their country, and who wish to seek incubation services in Brazil or Portugal.

This study has limitations regarding the elaboration of the samples. It may not have considered the whole variety of incubators in the two countries, nor the incubators' focus, which, eventually, could have brought more information about the role of complementary assets in the incubation process (Vanderstraeten et al., 2016). Also, as a complement to this research, we suggest a fragmented view by region of each country on the characteristics of the incubation process or, eventually, confront countries with more significant cultural and economic disparities. The incubaters' and their leaders' age can determine differences in business incubation (Carvalho & Galina, 2015), and that can be tested for the disparity of services offered and the survival of its tenants. On other hand, further analysis should investigate which BI differences impact their performance in the short-run, and long-run.

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Chapter 5 – Discussion, contributions, limitations, and future research

This research contributes to the extant body of strategy literature, with a particular focus on entrepreneurship studies and, more specifically, on the domain of the business incubation process. Our investigation delves into the various categories and degrees of complementary assets, as proposed by Teece (2006), which are offered to incubated firms. These assets, in turn, serve as determinants for evaluating the performance of business incubators, a criterion ascertained through the survival rates of companies that have completed their incubation period. This research substantiates the premise that the incubation process plays a pivotal role in bolstering the capabilities and competencies of incubated firms, which subsequently enable them to thrive independently post-incubation. Consequently, our primary objective in this study is to assess the effectiveness of incubators in fulfilling their core mission: equipping firms with the tools necessary for long-term survival.

The incubation process is characterized by its dynamic nature and is influenced by both internal and external factors inherent to the incubator's operating environment. In this thesis, we endeavor to scrutinize the significance of each incubator's intrinsic characteristics in forecasting its overall success. What follows is a presentation of the objectives and research inquiries that have been examined throughout the course of this thesis.

5.1 Objectives and research questions

5.1.1 General objective

The general objective of this thesis is to research on the performance of business incubators by identifying the influence of complementary assets offered in the incubation period on the survival of graduated firms. This research employed the survival rate of the firms after leaving the hatching period to assess incubators' success since "one of the primary objectives of business incubators is the promotion of survivability and the positive development of their tenant companies" (Schwartz, 2009, p.403).

5.1.2 Specific objectives

The general objective is decomposed in four specific objectives, as follows:

1) To provide an overview of the foundational concepts, limitations, and contemporary developments in the field of research pertaining to the performance of business incubators. This overview should involve a comprehensive analysis of the thematic framework, interrelationships

among the various approaches comprising this framework, and an identification of the predominant facets that have been the subject of research within this domain (Chapter 2);

2) To examine the efficacy of business incubators by assessing the significance of complementary resources in facilitating the sustainability of new firms that have completed their incubation period, using a sample of Brazilian-based incubators (Chapter 3);
3) To assess the role of entrepreneurial environment as a moderator in the effect of the complementary assets on the performance of Brazilian business incubators (Chapter 3);
4) To conduct a comparative analysis of the factors influencing the performance of business incubators in the respective contexts of Brazil and Portugal. (Chapter 4).

5.1.3 Research questions

Linked to the general objective of this thesis, the general research question is expressed as follows: **"**What role do complementary assets play on incubators' performance?"

The specific **research questions, associated to each specific objective are the following:**

1) How is the structure of academic knowledge built, and what are the research trends on business incubators, complementary assets, and performance? (Chapter 2)

2) What is the role of complementary assets in the performance of incubators? ((Chapter 3)

3) Are there any differences in incubation practices between incubators in Brazil and Portugal? (Chapter 4)

4) How do the institutional environment and economic context affect the role of complementary assets on the performance of incubators? (Chapter 4)

To reach this thesis' objectives, we prepared three papers, which constitute chapters 2 to 4. The first study, bibliometric, was conducted with a sample of 299 articles collected on the academic portal Web of Science (www.webofknowledge.com) using the words "incubat*" and "performance." We used bibliometric techniques of co-citation and co-word analyses. The research findings depicted the main factors in the sample pointed as the drivers of incubator success through their tenants' survival and growth. These factors relate to tangible and intangible asset provision, such as shared physical structure, process and routine formalization, and networking activities. Further, the co-word analysis reveals that there are three fields of research on incubation success: (1) performance factors and conditions, (2) incubation process, and (3) networking aspects.

Given what was found in Paper 1 (Chapter 2), our second study (Chapter 3) had a confirmatory character. For this study, we adopted information about graduated companies, that is, in the post-incubation phase, from Brazilian business incubators. We used primary and secondary data on the incubation process and the graduated companies of each incubator in the sample. We characterized the success factors of the incubation process found in the previous study as complementary assets (Teece, 2006). This study contributed to the objective of the thesis by elucidating that the complementary assets provided by incubators in the form of physical infrastructure, formalization, and legitimation and incorporated by companies through the development of capabilities and capacities make, in fact, the difference for their survival in the post-incubation phase. The results showed that companies that received "more" complementary assets are more successful and that, among the assets, legitimation is the most important. This research also showed that if companies operate in an entrepreneurial environment, they will have greater possibility of success, since the environment positively moderates the impact of legitimation.

The third study (Chapter 4) compares the incubation processes between Brazilian and Portuguese incubators regarding the assets they supply to the incubated companies. Although Brazil and Portugal have many traits in common, for example, in terms of language and cultural proximity, and that, therefore, comparative studies between these countries may not reveal substantial differences, we found essential discrepancies regarding the factors that drive success in incubation. This study shows, regarding the predominance of the type of complementary assets offered, meaning the relative participation of one asset over the others, that infrastructure has a relevant position in Brazilian incubators and formalization in Portuguese incubators; that is, they have a more significant impact on the survival of Brazilian and Portuguese graduate firms respectively. In addition, we found that legitimacy is essential for incubators in both countries, confirming, for Brazilian incubators, the result found in the second study (Chapter 3).

5.2 Contributions

This thesis answered the research questions and achieved its objective by studying business incubators' performance and identifying the influence of complementary assets provided during the incubation period on the survival of graduated firms. The thesis brings contributions to the academy and the practice of incubator managers or young companies that plan an incubation period in their development. Through three studies, we identified that incubated firms suffer an imprinting effect (Stinchcombe, 1965; Sydow et al., 2009) due to the specialized complementary assets they received, increasing their survival probability after leaving the incubator. As previously explained, these assets'

nature differs between Brazil and Portugal incubators. Formalizing processes and operational routines are aimed internally at the incubated firms. Formalization efforts neutralize new companies' deficiencies by promoting the efficient use of resources, establishing decision-making processes, and their managers' roles. Therefore, they are a catalytic agent of learning and the development of new skills and competencies. Formalization has the most significant influence among Portuguese incubators.

The provision of physical infrastructure, often offered at subsidized rates, emerges as a pivotal determinant that significantly impacts the efficacy of Brazilian incubators. This impact could be intimately intertwined with the economic and institutional heterogeneity characterizing diverse Brazilian regions. This diversity in economic conditions and the varied institutional frameworks across the nation's geographic and administrative divisions underscore the heightened importance of readily accessible physical infrastructure. Such infrastructure, comprising facilities, workspace, and technological amenities, serves as a foundational pillar for the tenants of these incubators. Making this type of asset available is essential to their tenants, as they can suffer less impact in resource allocation and utilization.

However, this intricate interplay between the provision of infrastructure and incubator performance does not manifest itself to the same degree in the context of Portugal. The reason behind this divergence can be attributed to the distinctive economic landscape of Portugal, which, in contrast to Brazil, exhibits a comparatively higher degree of homogeneity in economic development. This economic uniformity is posited as a plausible explanation for the relatively reduced significance of subsidized infrastructure on the incubator performance observed in the Portuguese setting.

In summary, juxtaposing these findings underscores the critical role of physical infrastructure in the success of Brazilian incubators, a phenomenon potentially exacerbated by the economic and institutional disparities among different regions of the country. Conversely, the more homogeneous economic development landscape in Portugal appears to mitigate the pronounced impact of subsidized infrastructure on incubator performance. This dichotomy underscores the importance of considering regional economic and institutional diversity when evaluating the determinants of incubators’ success in distinct national contexts. Figure 5.1 presents a summary of the thesis main findings.

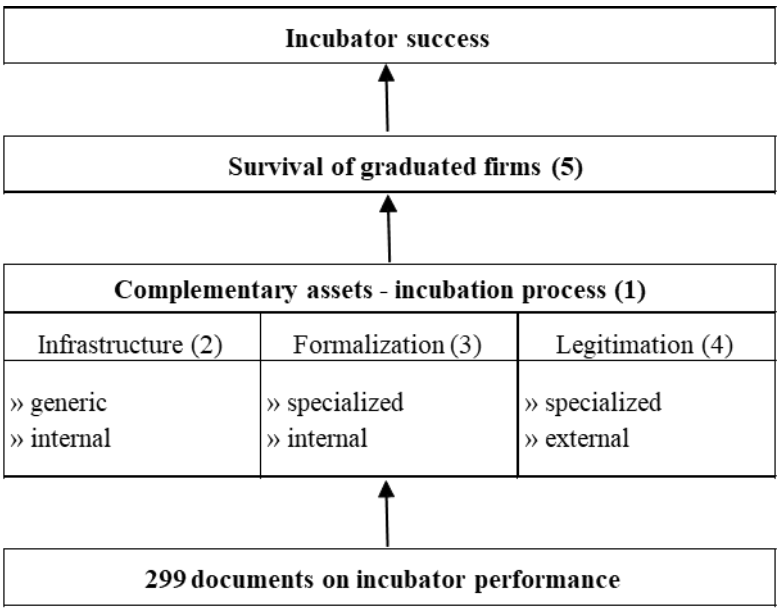

Figure 5.1. Summary of the thesis findings
Source: own elaboration

Points to be noticed in Figure 5.1. The numbers in the following points refer to the numbered topics in Figure 5.1. These points aim to summarize and consolidate the results obtained in this investigation.

(1) Through Chapter 2, we identified and characterized the main services provided during incubation.

(1) We conceptualized these services as complementary assets, particularly concerning formalization and legitimation, whose purpose is to mitigate the deficiencies common to small and new ventures. Tenants suffer an imprinting process during the hatching period by developing capabilities and skills and carrying these benefits along the life cycle, increasing success likelihood. (Chapter 3)

(3) and (4) Specialized complementary assets, such as formalization and legitimation-based services offered during incubation are essential to the success of graduated firms. (Chapter 3)

(2) Infrastructure services are more critical to Brazilian incubators' success than Portuguese ones. (Chapter 4)

(3) Provision of formalization services is more critical to Portuguese incubators' success. (Chapter 4)

(4) Legitimation-based provision impacts Brazilian Incubators' success positively when predominant over the two other complementary assets and has its effect magnified in entrepreneurial environments. (Chapter 3 and Chapter 4)

(4) Equally impacts Brazilian and Portuguese incubators. (Chapter 4)

(5) The entrepreneurial environment positively moderates the relationship between the provision of specialized complementary assets made available by the incubators and the graduated firms' performance after leaving the incubator (Chapter 3).

Further, as observed in the findings of our models in Chapter 3, incubator occupation rate positively impacts performance, although it obeys an inverted-U relation, assuming that at a certain point, as occupation rate increases, the effect on performance decreases. Also, the positive coefficient for MHDI, the incubator location city human development index, suggests that the best incubators choose the more developed cities, but the coefficients were not statistically significant.

5.3 Limitations and suggestions for the research agenda

There are limitations in the three studies of this thesis. Bibliometrics allows identifying patterns and relationships, encompassing the whole range of a body of literature (Donthu et al., 2021). Then, the findings of Study 1 were grounded using the logic and techniques of bibliometrics to understand and identify the factors responsible for an incubator's success. Our findings were derived from a method that allows the analysis of a broad scope of the literature, showing evidence of relationships that might not be evoked in strictly qualitative analysis. Thus, this study brings a methodological contribution to show how science mapping techniques can identify common approaches within a fragmented collection of documents. However, this work has inherent limitations related to the method and its temporal nature. Therefore, exploring the relationships between the incubation process and performance with other approaches is an opportunity. We recommend that future works expand this scope using the same method but introduce temporal brackets to assess the evolution of the approaches on this topic. Also, like any other review, this study did not cover all the research on the topic. As a suggestion for future studies, it is recommended to include the Scopus database in the survey, since studies may not be included in the Web of Science database used here.

As for the second and third studies, the main limitations are associated with collecting information. Despite the care taken, either by triangulating the information or by statistical tests, it is worth, in future studies, proposing a different way of obtaining the data, through interviews or by sending several forms to each incubator and later comparing the results. As in any statistical study, the sample size can consistently be increased with robustness and statistical significance gains. The size of the samples used in studies 2 and 3, despite reflecting the existing variation between incubators in each country, is a limitation that future studies can neutralize. Finally, we did not collect information on start-ups' pre-incubation capabilities and ties, which would improve the incubation process and potentialize

the start-ups to accumulate internal and external resources or exploit existing ones. Despite these limitations, this thesis brings valuable insights into the path to understanding the effects of complementary assets on business incubation performance.

Even at the risk of being repetitive, we concentrated on some of the research suggestions presented in this thesis. Here, we focus only on the suggestions considered essential to deepen the understanding of the theme. These three research trends are linked with incubators' performance, the factors that drive success as antecedents of success itself.

Below, we show some testable propositions that can increase the knowledge, as more field data are collected based on the three pillars that emerged from this thesis: performance drivers, incubation process, and relational networks. These topics are intertwined, and their thresholds point to the following:

(1) The incubator segmentation and specialization. Incubators may be linked to universities, corporations, governmental organizations, and science parks, linked to several organizations. Is there a business model that best fits each incubator type?
(2) Accelerators, which are pointed to as the fourth incubation generation. The hatching period is shorter than in the traditional incubators, and the focus is scale-up intensive.
(3) Networking activities must underlie the services provided by the incubators to potentialize results.
(4) Business incubators focus on facilities and infrastructure and must concentrate more on networking, marketing, and access to financing.
(5) To develop networking capabilities during incubation to enhance start-ups' performance.
(6) The role of the incubator entrepreneurial orientation possibly acts as a mediator in internal and external networks promoted. Further, the moderating effect of environmental dynamism also positively impacts the incubation process and star-tups' success.

For future research, the avenues and propositions presented within this thesis can serve as a foundation upon which to build and incorporate additional theoretical perspectives into a more comprehensive framework on the interplay of the incubation process, incubator performance, and the contextual environment. This expansion of theoretical perspectives has the potential to yield a deeper understanding of the intricate dynamics at play within the field of business incubation. Such an enriched framework can not only contribute to the refinement of existing incubation practices, but also it can aid in the development of more nuanced strategies for enhancing incubator performance in diverse contextual settings.

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Appendix 1 – Form sent to business incubators

Investigação académica sobre Incubação de Empresas

Título da pesquisa: **"O papel dos ativos complementares no desempenho de incubadoras de empresas"**

Exmo(a) Senhor(a)

Diretor(a) da Incubadora XPTO

Caro respondente,

A presente pesquisa sobre incubação de empresas integra-se numa dissertação para a conclusão do Doutoramento em Métodos Quantitativos Aplicados à Economia e à Gestão em curso na Universidade do Algarve e tem como objetivo identificar o papel das incubadoras em reduzir as fragilidades das *start-ups*, através do tipo de serviços fornecidos às empresas apoiadas, causando um impacto positivo na sua sobrevivência e desempenho, após o período de incubação.

Neste contexto, muito agradecemos a sua colaboração e da organização que dirige, através do preenchimento do questionário disponível a seguir. O tempo de resposta estimado é de cerca de 15 minutos, os dados coletados serão confidenciais e o anonimato do respondente será respeitado. Apenas serão publicados dados de forma agregada, sem identificar incubadora/respondente. Em caso de dúvida ou necessidade de esclarecimentos, por favor entrar em contato com Luiz Antonio de Camargo Guerrazzi, pelo e-mail luizguerrazzi@gmail.com ou pelo telefone 918 xxx x42.

Consideramos o seu contributo relevante para o sucesso da pesquisa, e agradecemos, desde já, em nome pessoal e da Universidade do Algarve, pelo tempo que irá dedicar a responder ao questionário. No final do questionário, caso deseje receber um resumo executivo da pesquisa, deixe o seu contacto.

Muito obrigado pela sua participação!

A – Identificação da incubadora

Nome:

Site:

Área (m²):

Idade da incubadora (anos):

Taxa de ocupação em (%) no final do ano, ano a ano (últimos três anos):

Por favor, nos três grupos abaixo, marque o que sua incubadora oferece, quantas opções forem necessárias.

Grupo 1

Escritório (físico);

Serviços de escritório;

Estacionamento;

Equipamentos de produção;

Laboratórios.

Grupo 2

Coaching;

Mentoring;

Consultorias (plano de negócios, gestão, marketing);

Formação em gestão;

Formação em vendas.

Grupo 3

Serviços de profissionais externos (patentes, contabilidade, consultorias)

Acesso a agentes financeiros;

Acesso a fornecedores;

Acesso a clientes.

Acesso a feiras e eventos

Em sua opinião, qual é o principal serviço prestado por esta incubadora?

_____

B – Empresas graduadas (que deixaram a incubadora)

Tempo médio de incubação (meses):

Empresas graduadas nos últimos três anos (ano a ano):

Com relação às graduadas, informadas acima, quantas permanecem ativas?

Destas, quantas tiveram desempenho de vendas crescente?

E quantas tiveram aumento no quadro de funcionários, independentemente do resultado de vendas?

Após graduadas, qual o período em que as empresas fornecem informações à incubadora (em meses)?

C – Identificação do respondente

Cargo:

Obrigado pela atenção e, se for de seu interesse, podemos compartilhar consigo o resultado da pesquisa.

Luiz Antonio de Camargo Guerrazzi

Appendix 2 – Beta regression

Correspondence between the variables presented in Table 3.7 and those of the Beta regressions, below.

Table 3.7	Beta regression
Attributes of infrastructure, formalization and legitimacy	Tot_EFL
Predominance of legitimacy attributes	L_particip
Predominance of infrastructure attributes	E_particip
Predominance of formalization attributes	F_particip
Entrepreneurial environment	Amb_empreend
Attributes x entrepreneurial environment	AExEFL
Predominance of legitimacy attributes x entrepreneurial environment	AExL_part
Predominance of infrastructure attributes x entrepreneurial environment	AExEpart
Predominance of formalization attributes x entrepreneurial environment	AExF_part
Occupation rate	Tax_ocup
Squared occupation rate	Tax_2
Focus of incubator	Foco
MHDI	IDHM
Squared MHDI	IDHM_2
Medium size	Media
Large size	Grande
Extra-large size	Extra

BETA REGRESSION RESULTS

library(betareg)

MODEL 1 – CONTROL VARIABLES

Coefficients (mu model with logit link):

	Estimate	Std. Error	z value	Pr(>|z|)	
(Intercept)	-2.69449	23.81137	-0.113	0.90990	
Tax_ocup	7.13467	2.58518	2.760	0.00578	**
Tax_2	-2.55487	1.99534	-1.280	0.20040	
Foco	0.21140	0.24127	0.876	0.38093	
IDHM	-3.80552	63.35873	-0.060	0.95211	
IDHM_2	5.83734	42.11558	0.139	0.88976	
Media	0.12560	0.31682	0.396	0.69179	
Grande	0.05132	0.35002	0.147	0.88344	
Extra	-0.70032	0.39643	-1.767	0.07730	.

Phi coefficients (phi model with identity link):

	Estimate	Std. Error	z value	Pr(>|z|)	
(phi)	5.618	1.985	2.83	0.00466	**

Exceedence parameter (extended-support xbetax model):

	Estimate	Std. Error	z value	Pr(>|z|)	
Log(nu)	-1.5922	0.6359	-2.504	0.0123	*

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Exceedence parameter nu: 0.2035
Type of estimator: ML (maximum likelihood)
Log-likelihood: -34.28 on 11 Df
Number of iterations in BFGS optimization: 66

Model 2 - H1

Coefficients (mu model with logit link):

	Estimate	Std. Error	z value	Pr(>|z|)	
(Intercept)	10.71046	17.72025	0.604	0.54557	
Tot_EFL	0.19747	0.06247	3.161	0.00157	**
Tax_ocup	6.20992	2.07036	2.999	0.00270	**
Tax_2	-2.87268	1.52878	-1.879	0.06024	.
Foco	0.10594	0.18609	0.569	0.56915	
IDHM	-41.28043	47.50518	-0.869	0.38487	
IDHM_2	30.04670	31.80640	0.945	0.34483	
Media	0.04809	0.23562	0.204	0.83828	
Grande	-0.01530	0.27089	-0.056	0.95496	
Extra	-0.36585	0.31766	-1.152	0.24944	

Phi coefficients (phi model with identity link):

	Estimate	Std. Error	z value	Pr(>|z|)	
(phi)	11.199	5.394	2.076	0.0379	*

Exceedence parameter (extended-support xbetax model):

	Estimate	Std. Error	z value	Pr(>|z|)
Log(nu)	-0.7982	0.5537	-1.442	0.149

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Exceedence parameter nu: 0.4501
Type of estimator: ML (maximum likelihood)
Log-likelihood: -30.09 on 12 Df
Number of iterations in BFGS optimization: 77

Model 3 - H2

Coefficients (mu model with logit link):

	Estimate	Std. Error	z value	Pr(>|z|)	
(Intercept)	5.39039	22.15019	0.243	0.80773	
L_particip	1.99987	1.14157	1.752	0.07980	.
Tax_ocup	6.56259	2.46825	2.659	0.00784	**
Tax_2	-2.51437	1.86287	-1.350	0.17710	**
Foco	0.17690	0.22786	0.776	0.43754	
IDHM	-25.35954	59.07677	-0.429	0.66773	
IDHM_2	19.78784	39.39415	0.502	0.61545	
Media	0.03720	0.30517	0.122	0.90298	
Grande	0.07833	0.32634	0.240	0.81031	
Extra	-0.68382	0.39078	-1.750	0.08014	.

Phi coefficients (phi model with identity link):

	Estimate	Std. Error	z value	Pr(>|z|)	
(phi)	6.871	3.350	2.051	0.0403	*

Exceedence parameter (extended-support xbetax model):

	Estimate	Std. Error	z value	Pr(>|z|)	
Log(nu)	-1.3111	0.7558	-1.735	0.0828	.

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Exceedence parameter nu: 0.2695
Type of estimator: ML (maximum likelihood)
Log-likelihood: -32.86 on 12 Df
Number of iterations in BFGS optimization: 139

Model 4 - H3

Coefficients (mu model with logit link):

```
              Estimate Std. Error z value Pr(>|z|)
(Intercept)    9.09109   21.21131   0.429  0.66822
E_particip    -3.61636    1.28262  -2.820  0.00481 **
Tax_ocup       7.39889    2.78305   2.659  0.00785 **
Tax_2         -3.30160    2.02834  -1.628  0.10358 **
Foco           0.25673    0.23064   1.113  0.26566
IDHM         -30.20814   56.61225  -0.534  0.59362
IDHM_2        22.90547   37.86679   0.605  0.54525
Media          0.16324    0.28899   0.565  0.57217
Grande        -0.02043    0.31423  -0.065  0.94816
Extra         -0.48684    0.36394  -1.338  0.18099
```

Phi coefficients (phi model with identity link):

	Estimate	Std. Error	z value	Pr(>|z|)	
(phi)	7.491	3.146	2.381	0.0173	*

Exceedence parameter (extended-support xbetax model):

	Estimate	Std. Error	z value	Pr(>|z|)	
Log(nu)	-1.2919	0.6321	-2.044	0.041	*

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Exceedence parameter nu: 0.2747
Type of estimator: ML (maximum likelihood)
Log-likelihood: -30.23 on 12 Df
Number of iterations in BFGS optimization: 137

Model 5 - H4

```
Coefficients (mu model with logit link):
            Estimate Std. Error z value Pr(>|z|)
(Intercept) -3.94378   23.91570  -0.165   0.8690
F_particip   0.88330    1.28023   0.690   0.4902
Tax_ocup     7.24080    2.65576   2.726   0.0064 **
Tax_2       -2.67051    2.03798  -1.310   0.1901
Foco         0.23632    0.24406   0.968   0.3329
IDHM        -1.36368   63.48202  -0.021   0.9829
IDHM_2       4.23419   42.17606   0.100   0.9200
Media        0.16462    0.32176   0.512   0.6089
Grande       0.02898    0.34918   0.083   0.9339
Extra       -0.63644    0.40049  -1.589   0.1120

Phi coefficients (phi model with identity link):
      Estimate Std. Error z value Pr(>|z|)
(phi)    5.678      2.010   2.825  0.00473 **

Exceedence parameter (extended-support xbetax model):
        Estimate Std. Error z value Pr(>|z|)
Log(nu)  -1.5775     0.6312  -2.499   0.0124 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Exceedence parameter nu: 0.2065
Type of estimator: ML (maximum likelihood)
Log-likelihood: -34.06 on 12 Df
Number of iterations in BFGS optimization: 162
```

Model 6 - H5a

Coefficients (mu model with logit link):

	Estimate	Std. Error	z value	Pr(>|z|)	
(Intercept)	10.1625	20.2464	0.502	0.615708	
Tot_EFL	0.3591	0.1032	3.479	0.000503	***
Amb_empreend	63.4716	23.5327	2.697	0.006993	**
AExEFL	-5.9619	2.5830	-2.308	0.020990	*
Tax_ocup	7.2233	2.3494	3.074	0.002109	**
Tax_2	-3.5194	1.7047	-2.064	0.038970	*
Foco	0.1699	0.2182	0.779	0.436178	
IDHM	-38.4659	54.9354	-0.700	0.483801	
IDHM_2	23.9822	36.9093	0.650	0.515847	
Media	0.2387	0.2696	0.885	0.375959	
Grande	0.1127	0.3082	0.366	0.714585	
Extra	-0.4812	0.3667	-1.312	0.189394	

Phi coefficients (phi model with identity link):

	Estimate	Std. Error	z value	Pr(>|z|)	
(phi)	9.324	4.023	2.318	0.0205	*

Exceedence parameter (extended-support xbetax model):

	Estimate	Std. Error	z value	Pr(>|z|)	
Log(nu)	-1.2968	0.5952	-2.179	0.0294	*

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Exceedence parameter nu: 0.2734
Type of estimator: ML (maximum likelihood)
Log-likelihood: -20.45 on 14 Df
Number of iterations in BFGS optimization: 204

Model 7 - H5b

```
Coefficients (mu model with logit link):
              Estimate Std. Error z value Pr(>|z|)
(Intercept)  -10.20261   22.40368  -0.455  0.64882
L_particip     1.55898    1.10519   1.411  0.01583 *
Amb_empreend  15.81542    5.07026   3.119  0.00181 **
AExL_part     -8.00297    5.10297  -1.568  0.01168 *
Tax_ocup       6.29163    2.36872   2.656  0.00790 **
Tax_2         -2.48015    1.82981  -1.355  0.17528
Foco           0.23952    0.22854   1.048  0.29461
IDHM          21.49630   60.32836   0.356  0.72160
IDHM_2       -14.69747   40.56268  -0.362  0.71710
Media         -0.01305    0.28649  -0.046  0.96368
Grande         0.05267    0.33066   0.159  0.87345
Extra         -0.90661    0.40272  -2.251  0.02437 *

Phi coefficients (phi model with identity link):
      Estimate Std. Error z value Pr(>|z|)
(phi)    7.345      3.348   2.194   0.0282 *

Exceedence parameter (extended-support xbetax model):
        Estimate Std. Error z value Pr(>|z|)
Log(nu)  -1.4433     0.7026  -2.054     0.04 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Exceedence parameter nu: 0.2361
Type of estimator: ML (maximum likelihood)
Log-likelihood: -25.2 on 14 Df
Number of iterations in BFGS optimization: 758
```

Model 8 - H5c

```
Coefficients (mu model with logit link):
              Estimate Std. Error z value Pr(>|z|)
(Intercept)    5.03608   23.11276   0.218  0.82751
E_particip    -5.98602    1.85689  -3.224  0.00127 **
Amb_empreend -30.99928   20.16465  -1.537  0.01242 *
AExEpart     112.09147   50.71670   2.210  0.02709 *
Tax_ocup       7.95156    2.72315   2.920  0.00350 **
Tax_2         -3.51496    2.02948  -1.732  0.08328 .
Foco           0.23939    0.24637   0.972  0.33121
IDHM         -11.33949   61.75195  -0.184  0.85430
IDHM_2         6.08159   41.46348   0.147  0.88339
Media          0.26174    0.30604   0.855  0.39241
Grande        -0.08482    0.34008  -0.249  0.80304
Extra         -0.69394    0.39978  -1.736  0.08260 .

Phi coefficients (phi model with identity link):
      Estimate Std. Error z value Pr(>|z|)
(phi)    6.594      2.324   2.837  0.00455 **

Exceedence parameter (extended-support xbetax model):
        Estimate Std. Error z value Pr(>|z|)
Log(nu)  -1.8072     0.6409   -2.82  0.00481 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Exceedence parameter nu: 0.1641
Type of estimator: ML (maximum likelihood)
Log-likelihood: -21.36 on 14 Df
Number of iterations in BFGS optimization: 240
```

Model 9 - H5d

```
Coefficients (mu model with logit link):
              Estimate Std. Error z value Pr(>|z|)
(Intercept)  -19.25365   25.17984  -0.765  0.44448
F_particip     2.52270    2.02769   1.244  0.21345
Amb_empreend  28.13678   15.15694   1.856  0.06340 .
AExF_part    -36.59903   43.61215  -0.839  0.40136
Tax_ocup       7.38121    2.78086   2.654  0.00795 **
Tax_2         -3.02835    2.06437  -1.467  0.14239
Foco           0.32330    0.25211   1.282  0.19971
IDHM          44.17227   66.87142   0.661  0.50890
IDHM_2       -30.49792   44.78910  -0.681  0.49592
Media          0.11793    0.30705   0.384  0.70092
Grande        -0.08829    0.35446  -0.249  0.80329
Extra         -0.84062    0.41256  -2.038  0.04159 *

Phi coefficients (phi model with identity link):
      Estimate Std. Error z value Pr(>|z|)
(phi)    6.018      2.237    2.69  0.00715 **

Exceedence parameter (extended-support xbetax model):
        Estimate Std. Error z value Pr(>|z|)
Log(nu)  -1.7101     0.6638  -2.576  0.00999 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Exceedence parameter nu: 0.1808
Type of estimator: ML (maximum likelihood)
Log-likelihood: -26.77 on 14 Df
Number of iterations in BFGS optimization: 234
```

Model 10 - TOTAL

```
Coefficients (mu model with logit link):
             Estimate Std. Error z value Pr(>|z|)
(Intercept)  -16.9683    34.1758  -0.497  0.61954
Tot_EFL        0.3352     0.1754   1.911  0.05594 .
E_particip    20.4169    21.5435   0.948  0.34328
F_particip    22.6805    21.5100   1.054  0.29169
L_particip    22.7533    21.5748   1.055  0.29160
Amb_empreend  23.3966    63.0562   0.371  0.71061
AExEFL        -4.7189     3.5611  -1.325  0.01851 *
AExEpart      67.6660    76.8935   0.880  0.37886
AExF_part    -12.8343    48.6206   0.264  0.79180
AExL_part     -8.1258     5.4300  -1.496  0.13453
Tax_ocup       9.0182     3.0566   2.950  0.00317 **
Tax_2         -4.1404     2.1448  -1.930  0.05355 .
Foco           0.2208     0.2486   0.888  0.37437
IDHM         -24.4992    67.9001  -0.361  0.71824
IDHM_2        14.2304    45.3970   0.313  0.75393
Media          0.3887     0.3444   1.129  0.25905
Grande         0.1322     0.3597   0.368  0.71323
Extra         -0.6705     0.4212  -1.592  0.11143

Phi coefficients (phi model with identity link):
      Estimate Std. Error z value Pr(>|z|)
(phi)    6.704      2.472   2.712  0.00669 **

Exceedence parameter (extended-support xbetax model):
        Estimate Std. Error z value Pr(>|z|)
Log(nu)  -1.9219     0.6988   -2.75  0.00595 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Exceedence parameter nu: 0.1463
Type of estimator: ML (maximum likelihood)
Log-likelihood: -18.25 on 20 Df
Number of iterations in BFGS optimization: 247
```

REFERENCE

Cribari-Neto, F., & Zeileis, A. (2010). Beta regression in R. *Journal of Statistical Software*, *34*, 1-24.

Annex 1 – Brazilian business incubators in the sample

#	Incubadora de Empresas	Região do Brasil	Estado	Cidade	Web
1	IET - Incubadora Empresarial Tecnológica	NE	Alagoas	Maceió	https://cesmac.edu.br/cesmac/incubadora
2	INCUBADORA DE EMPRESAS DE ALAGOAS	NE	Alagoas	Maceió	https://ufal.br/ufal/pesquisa-e-inovacao/empreendedorismo/incubadoras
3	Núcleo Incubador de Empresas de Pindorama	NE	Alagoas	Coruripe	http://www.al.agenciasebrae.com.br/sites/asn/uf/AL/incubadora
4	Centro de Empresas Nascentes – CENA	NE	Bahia	Salvador	www.portaldocena.com.br
5	INOVAPOLI - Incubadora de Base Tecnológica	NE	Bahia	Salvador	www.inovapoli.ufba.br
6	Incubadora de Empresas de Base Tecnológica	NE	BA	Camaçari	www.incubatec.ceped.ba.gov.br
7	Incubadora Tecnologica de Campina Grande – ITCG	NE	Paraíba	Campina Grande	http://itcg.org.br/2017/03/07/programa-de-incubacao
8	INCUBADORA CAIS DO PORTO	NE	Pernambuco	Recife	http://www.portodigital.org/diferenciais/empreendedorismo/incubadora
9	C.E.S.A.R - Centro de Estudos e Sistemas Avançados do Recife	NE	Pernambuco	Recife	https://www.cesar.org.br/
10	Incubatec Rural - PRAE/UFRPE	NE	Pernambuco	Recife	http://www.incubatec.ufrpe.br/sobre
11	INCUBATEP - Incubadora de Empresas de Base Tecnológica do Estado de Pernambuco	NE	Pernambuco	Recife	http://www.itep.br/incubacao
12	INCUBANECTAR	NE	Pernambuco	Recife	www.nectar.org.br
13	Parque de Desenvolvimento Tecnológico – PADETEC	NE	Ceará	Fortaleza	www.padetec.ufc.br
14	INCUBADORA DE EMPRESAS DO IFCE	NE	Ceará	Fortaleza	http://www.ifce.edu.br/extensao/incubadora.html
15	Incubadora de Empresas de base Tecnológica – ITEC	NE	Sergipe	Aracaju	http://itecse.org/
16	Incubadora Tecnógica e Multissetorial do Sertão do Cabugi - INEAGRO-CABUGI	NE	Rio Grande do Norte	Angicos	https://ineagrocabugi.wixsite.com/ineagrocabugi
17	Fundação Guimarães Duque	NE	Rio Grande do Norte	Mossoró	www.fgduque.org.br

18	Centro de Incubação Tecnológica do Semiárido – CITECS	NE	Rio Grande do Norte	Mossoró	http://portal.uern.br/citecs/
19	INCUBADORA TECNOLÓGICA NATAL CENTRAL – ITNC	NE	Rio Grande do Norte	Natal	http://www2.ifrn.edu.br/itnc
20	INCUBADORA DE COOPERATIVAS E EMPREENDIMENTOS POPULARES – INCOPE	NE	Rio Grande do Norte	Natal	INCOPE RN
21	AYTY - Incubadora de Empresas do IFAM	NO	Amazonas	Manaus	http://www.ifam.edu.br/ayty/
22	Centro de Desenvolvimento Empresarial e Tecnológica - CDTECH	NO	Amazonas	Manaus	https://ufam.edu.br/orgao-suplementar-2/cdtech-2
23	Incubadora de Empresas de Base Tecnológica da UFPA - PIEBT	NO	PA	BELEM	www.universitec.ufpa.br
24	Centro de Incubação de Empresas - CIE/IEPA	NO	Amapá	Macapá	www.iepa.ap.gov.br/cie
25	CASULO - Incubadora de Empresas do UniCEUB	CO	Distrito Federal	Brasília	https://www.uniceub.br/comunidade/
26	ITEC- Incubadora de Empresas da Universidade Católica	CO	Distrito Federal	Taguatinga	www.ucb.br/itec
27	CDT	CO	Distrito Federal	Brasília	http://www.cdt.unb.br/programaseprojetos/index
28	FENIX - Incubadora de Empresas da UEMS	CO	Mato Grosso do Sul	Dourados	www.uems.br/fenix
29	Incubadora Municipal Francisco Giordano Neto	CO	Mato Grosso do Sul	Campo Grande	http://portal.capital.ms.gov.br/incubadoras/giordanoneto
30	IMNEH - Incubadora Municipal Norman Edward Hanson	CO	Mato Grosso do Sul	Campo Grande	http://portal.capital.ms.gov.br/incubadoras/norman
31	INTERP - INCUBADORA DE EMPRESAS	CO	Mato Grosso do Sul	Campo Grande	www.interp.com.br
32	Incubadora Municipal Mário Covas	CO	Mato Grosso do Sul	Campo Grande	http://portal.capital.ms.gov.br/incubadoras/mariocovas
33	Pantanal Incubadora Mista de Empresas	CO	Mato Grosso do Sul	Campo Grande	www.pime.ufms.br
34	Incubadora Municipal Zé Pereira (Artesanato)	CO	Mato Grosso do Sul	Campo Grande	inczepereira@gmail.com / www.capital.ms.gov.br/incubadoras

35	I-DEIA	CO	Mato Grosso	Rondonópolis	www.incubadoraideia.com.br
36	Arca Multincubadora (tecnológica, social e cultura, agroecológica)	CO	Mato Grosso	Cuiabá	http://www.ufmt.br/cartaservicos/
37	ATIVA INCUBADORA DE EMPRESAS EM AGRONEGÓCIO	CO	Mato Grosso	Santo Antonio do Leveger	http://proex.ifmt.edu.br/conteudo/
38	Incubadora de Empresas Sucesso De Campo Verde	CO	Mato Grosso	Campo Verde	www.campoverde.gov.br
39	PROINE - PROGRAMA DE INCUBAÇÃO DE EMPRESAS DA UNIVERSIDADE FEDERAL DE GOIÁS	CO	Goiás	Goiânia	https://cei.ufg.br/
40	Instituto Gênesis	SE	Rio de Janeiro	Rio de Janeiro	www.genesis.puc-rio.br
41	IEBTec - Incubadora de Empresa de Base Tecnológica - IPRJ / UERJ	SE	Rio de Janeiro	Nova Friburgo	http://www.iebtec.uerj.br/
42	INCUBADORA DE EMPRESAS DO LNCC	SE	Rio de Janeiro	Petrópolis	www.incubadora.lncc.br
43	INCUBADORA DE EMPRESAS TECNOLÓGICAS DO CEFET/RJ - IETEC-CEFET/RJ	SE	Rio de Janeiro	Rio de Janeiro	incubadora.cefet-rj.br
44	Incubadora Tecnológica de Cooperativas Populares – ITCP COPPE UFRJ	SE	Rio de Janeiro	Rio de Janeiro	www.itcp.coppe.ufrj.br
45	Incubadora de Empresas da COPPE/UFRJ	SE	RJ	Rio de Janeiro	www.inc.coppe.ufrj.br
46	Experimental AD/Venture Participações Ltda	SE	Rio de Janeiro	Rio de Janeiro	www.experimental.cc
47	Centro de Incubação de Atividades Empreendedoras - CIAEM	SE	Minas Gerais	Uberlândia	http://www.ciaem.ufu.br
48	FUMSOFT - Sociedade Mineira de Software	SE	Minas Gerais	Belo Horizonte	www.fumsoft.org.br
49	D. Incubadora de Empresas e Negócios de Design	SE	Minas Gerais	Belo Horizonte	blog www.incubadoradesign.com.br
50	INOVA - UFMG Incubadora de Empresas	SE	Minas Gerais	Belo Horizonte	www.inova.ufmg.br
51	Centro de Referência em Incubação de Empresas e Projetos de Ouro Preto - INCULTEC	SE	Minas Gerais	Ouro Preto	www.ufop.br/incultec
52	Incubadora de Empresas de Base Tecnológica HABITAT	SE	Minas Gerais	Belo Horizonte	www.incubadorahabitat.org.br

53	Incubadora de Empresas de Base Tecnológica da Universidade Federal de Lavras - Inbatec/UFLA	SE	Minas Gerais	Lavras	http://www.inbatec.ufla.br/
54	INCET - Incubadora de Empresa de Base Tecnológica da Fundação Educacional de Montes Claros	SE	Minas Gerais	Montes Claros	https://femc.edu.br/portal/facit/pagina/43-incet
55	Incubadora de Empresas de Baase Tecnológica de Itajubá - INCIT	SE	MG	Itajubá	www.incit.com.br
56	Incubadora de Empresas e Projetos do Inatel	SE	Minas Gerais	Santa Rita do Sapucaí	http://inatel.br/empreendedorismo/incubadora
57	INTEF - Incubadora de Empresas de Base Tecnológica da FAI	SE	Minas Gerais	Santa Rita do Sapucaí	em processo de construção
58	Incubadora Municipal de Empresas Sinhá Moreira - IME/ PROINTEC	SE	Minas Gerais	Santa Rita do Sapucaí	www.prointec.com.br
59	Centro Regional de Inovação e Tranferência de Tecnologia - CRITT/UFJF	SE	Minas Gerais	Juiz de For a	www.ufjf.br/critt
60	Incubadora de Empresas de Base Tecnológica CenTev/UFV	SE	Minas Gerais	Viçosa	http://www.centev.ufv.br/incubadora/
61	INDETEC - Incubadora de Desenvolvimento Tecnológico e Setores Tradicionais do Campo das Vertentes	SE	MG	São João del Rei	www.ufsj.edu.br/indetec
62	INTEC - Incubadora Tecnológica de Mogi das Cruzes	SE	São Paulo	Mogi das Cruzes	www.intecmogi.com.br
63	INCUBADORA DE EMPRESAS DE OSASCO	SE	SP	OSASCO	www.incubadoradeosasco.com.br
64	INCTEC - Incubadora de Empresas de Base Tecnológica IN NOVA	SE	São Paulo	Santo André	Não está no ar
65	Centro de Inovação, Empreendimento e Tecnologia - CIETEC	SE	São Paulo	São Paulo	www.cietec.org.br
66	SUPERA – Incubadora de Empresas de Base Tecnológica de Ribeirão Preto	SE	São Paulo	Ribeirão Preto	www.fipase.org.br
67	PROSPECTA - Incubadora Tecnológica de Botucatu	SE	São Paulo	Botucatu	www.prospecta.org.br
68	Incubadora Tecnológica Univap	SE	São Paulo	São José dos Campos	www.incubadoraunivap.com.br
69	CIATEC	SE	São Paulo	Campinas	www.ciatec.org.br
70	Incamp - Incubadora de Empresas de base Tecnológica da UNICAMP	SE	São Paulo	Campinas	www.inova.unicamp.br
71	Incubadora Tecnológica Univap - Revap	SE	São Paulo	São José dos Campos	www.incubadorarevap.com.br

72	INOVA Sorocaba	SE	São Paulo	Sorocaba	www.inovasorocaba.org.br
73	Associação pela Excelência do Software de Campinas Núcleo SOFTEX Campinas	SE	São Paulo	Campinas	www.cps.softex.br
74	CIE – CENTRO INCUBADOR DE EMPRESAS DE SÃO JOSÉ DO RIO PRETO	SE	São Paulo	São José do Rio Preto	www.cieriopreto.com.br
75	Incubadora de Negócios de São José dos Campos	SE	SP	São José dos Campos	incubadoradenegocios.org.br
76	INCUBADORA EMPRESARIAL SANTOS DUMONT	SU	PR	FOZ DO IGUAÇU	http://www.pti.org.br/incubadora-empresarial
77	FUNDETEC - Fundação para o Desenvolvimento Científico e Tecnológico	SU	Paraná	Cascavel	https://www.fundetec.org.br/index.php
78	Incubadora de Inovações da Universidade Tecnológica Federal do Paraná - IUT-MD	SU	Paraná	Medianeira	http://www2.md.utfpr.edu.br/iut/
79	INTEC – Incubadora Tecnológica de Curitiba	SU	PR	Curitiba	www.tecpar.br/intec
80	Incubadora de Inovações da UTFPR - Ponta Grossa	SU	Paraná	Ponta Grossa	www.utfpr.edu.br
81	Incubadora do Senai	SU	PR	Curitiba	www.pr.senai.br/incubadora
82	Incubadora de Inovações da Universidade Tecnológica - IUT	SU	Paraná	Curitiba	http://www.utfpr.edu.br/curitiba/estrutura-universitaria
83	StartUP - Incubadora de Projetos e Empresas da Universidade Positivo	SU	Paraná	Curitiba	www.up.com.br/incubadora
84	Incubadora Tecnológica de Maringá	SU	Paraná	Maringá	www.incubadoramaringa.org.br
85	Incubadora Internacional de Empresas de Base Tecnológica da UEL – INTUEL	SU	Paraná	Londrina	www.aintec.com.br
86	Incubadora Multisetorial de Empresas de Base Tecnologica e Inovação RAIAR	SU	Rio Grande do Sul	Porto Alegre	www.pucrs.br/raiar
87	CEI - Centro de Empreendimentos de Informática da UFRGS	SU	Rio Grande do Sul	Porto Alegre	www.inf.ufrgs.br/cei
88	IEITEC - Incubadora Tecnológica Empresarial de Canoas	SU	Rio Grande do Sul	Canoas	www.ieitec.com.br
89	Incubadora ULBRATECH Canoas	SU	Rio Grande do Sul	Canoas	www.ulbratech.com.br
90	Incubadora Tecnológica HESTIA (Deusa Grega da Hospitalidade)	SU	Rio Grande do Sul	Porto Alegre	www.ufrgs.br

91	Incubadora Empresarial do Centro de Biotecnologia - IE-Cbiot	SU	RS	Porto Alegre	www.cbiot.ufrgs.br/iecbiot/
92	UNITEC - Unidade de Inovação e Tecnologia	SU	Rio Grande do Sul	São Leopoldo	www.tecnosinos.com.br
93	Incubadora Tecnológica da Feevale – ITEF	SU	Rio Grande do Sul	Campo Bom	https://www.feevale.br/techpark/o-parque/como-ingressar
94	Incubadora Tecnológica CIENTEC - Fundação de Ciência e Tecnologia	SU	Rio Grande do Sul	Porto Alegre	www.cientec.rs.gov.br
95	ITEC - Sociedade Incubadora Tecnológica de Caxias do Sul	SU	Rio Grande do Sul	Caxias do Sul	www.itec.org.br
96	INOVATES - Centro Tecnológico da Univates	SU	Rio Grande do Sul	Lajeado	www.inovates.br
97	Centro de Incubação de Empresas da Região Sul	SU	Rio Grande do Sul	Pelotas	www.ucpel.edu.br/ciemsul
98	INCUBADORA TECNOLÓGICA LIBERATO - ITEL	SU	Rio Grande do Sul	Novo Hamburgo	www.liberato.com.br
99	MIDI - Tecnológico	SU	Santa Catarina	Florianópolis	www.miditecnologico.com.br
100	CELTA-Centro Empresarial para Laboração de Tecnologias Avançadas	SU	Santa Catarina	Florianópolis	www.celta.org.br
101	Fundação Centro de Inovação e Tecnologia de Biguaçu	SU	Santa Catarina	Biguaçu	www.citeb.com.br
102	ITFETEP - Incubadora Tecnológica de São Bento do Sul	SU	Santa Catarina	São Bento do Sul	itfetep.org.br
103	JaraguaTec Centro de Inovação e Pesquisas Tecnológicas - JARAGUATEC	SU	Santa Catarina	Jaraguá do Sul	www.jaraguatec.org.br
104	Instituto Gene Blumenau	SU	Santa Catarina	Blumenau	www.institutogene.org.br
105	GTEC - Núcleo Gerador de Empresas de Desenvolvimento Integrado dde Incubação	SU	Santa Catarina	Rio do Sul	www.gtec.unidavi.edu.br
106	Micro Distrito de Base Tecnológica de Lages - Incubadora MIDILages	SU	Santa Catarina	Lages	www.uniplac.net/midilages
107	Incubadora Tecnológica da Unochapecó - INCTECH	SU	Santa Catarina	Chapecó	https://www.unochapeco.edu.br/inctech
108	Incubadora Tecnológica Softville	SU	Santa Catarina	Joinville	www.softville.org.br
109	UNIINOVA	SU	Santa Catarina	Itajaí	www.univali.br/uniinova

Note. Brazilian regions: SU (south); SE (southeast); CO (central); NE (northeast); NO (north).

Annex 2 – Portuguese business incubators in the sample

#	Incubadora de Empresas	Web
1	Centro de Ideias e Negócios - In Castro	castroverdeinveste.pt
2	Centro Empresarial Idanha-a-Nova	http://cmcd.pt/empreendedorismo/centro-empresarial/
3	Centro de Negócios e Inovação de Rio Maior (CNIRM)	http://cnirm.pt
4	IPStartUp - Polytechnic Institute of Setúbal	http://ipstartup.ips.pt
5	CETEC - Centro de Empresas Tecnológicas de Coimbra	http://novotecna.pt
6	NIDE - Ninhos de Empresa da Fundação da Juventude	http://startupjuventude.pt
7	NIDE - Ninhos de Empresa da Fundação da Juventude	http://startupjuventude.pt
8	AEL-STARTUP - INCUBADORA DE EMPRESAS DE LAFÕES	http://www.ael.pt/
9	Caldas Empreende	http://www.airo.pt/caldas-empreende
10	Amadora TECH	http://www.amadorainova.pt/amadora-tech
11	BioBIP - Bioenergy Business Incubator of Portalegre	http://www.biobip.pt/
12	Associação para o Desenvolvimento do BRIGANTIA ECOPARK	http://www.brigantia-ecopark.pt
13	Business Factory - Incubadora de Negócios do Concelho de Mafra	http://www.cm-mafra.pt/pt/economia/business-factory
14	Agência DNA Cascais	http://www.dnacascais.pt
15	Famalicão Made IN	http://www.famalicaomadein.pt
16	IEFF - Incubadora de Empresas da Figueira da Foz	http://www.ieff.pt
17	Pólo de Incubação de Albergaria-a-Velha (AAV) da Incubadora de Empresas da Região de Aveiro (IERA)	http://www.iera.pt/polos/albergaria
18	VougaPark – Centro de Inovação	http://www.iera.pt/polos/vougapark
19	Associação para o Centro de Incubação do Minho	http://www.incubo.eu
20	Mentortec	http://www.mentortec.eu
21	MOVELTEX - Centro de Competências e de Incubação de Empresas	http://www.moveltex.com
22	OPEN - Oportunidades Específicas de Negócio	http://www.open.pt
23	REGIA DOURO PARK	http://www.regiadouro.com
24	Startup Alentejo - Vendas Novas Empreende	http://www.startupalentejo.com
25	Startup Lisboa	http://www.startuplisboa.com
26	IEUA-Business Incubator of the University of Aveiro	http://www.ua.pt/ieua
27	UNIVERSIDADE DA BEIRA INTERIOR (UBINNOVATIVE)	http://www.ubi.pt
28	IET - Instituto Empresarial do TÃ¢mega	https://iet.pt/
29	IUPEN	https://movetofundao.pt/
30	Incubadora Go-On	https://nonagon.pt/apresentacao-incubadora/
31	Startup Madeira	https://startupmadeira.eu/

32	StartUp Montemor-o-Novo	https://startupmontemornovo.com/
33	StartUp Portimão	https://startupportimao.pt/index.php/pt/
34	Inov.Point - TagusValley	https://tagusvalley.pt/inov-point.php
35	UPTEC - Parque de Ciência e Tecnologia da Universidade do Porto	https://uptec.up.pt
36	Incubadora de Empresas da AIRV	https://www.airv.pt/index.php/incubadoraempresasairvh
37	Praia Links - Incubadora de Negócios e Ninho de Empresas da Praia da Vitória	https://www.facebook.com/incubadorapraialinks/
38	IPN-Incubadora Instituto Pedro Nunes e Universidade of Coimbra	https://www.ipn.pt
39	LISPOLIS - Centro de Incubação e Desenvolvimento	https://www.lispolis.pt
40	StartUp Braga	https://www.startupbraga.com/
41	Incubadora do Curia Tecnoparque	https://www.wrc.pt
42	ÉvoraTech - Incubadora de Empresas de Base Tecnológica de Évora	under construction
43	Business Factory	www.businessfactory.pt
44	UALG TEC START - Incubadora de Empresas da Universidade do Algarve	www.cria.pt
45	INOPOL Academia de Empreendedorismo	www.inopol.ipc.pt
46	Inovagaia	www.inovagaia.pt
47	Labs Lisboa	www.labslisboa.pt
48	Madan Parque	www.madanparque.pt
49	Sines Tecnopolo	www.sinestecnopolo.org
50	StartUp Angra	www.startupangra.com
51	Incubadora Taguspark	www.taguspark.pt
52	Tec Labs	www.teclabs.pt