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Porto Alegre for startups: a framework for startup ecosystems

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Abstract: This study aims to propose a framework to map the startup ecosystem in the city of Porto Alegre. A framework-based review was used, and secondary data were collected from reports on the city of Porto Alegre and the state of Rio Grande do Sul. As a result, a framework for startup ecosystems was created with six dimensions: sustainability, economic, social, human capital, infrastructure, and political-legal. The results show Porto Alegre as one of the top 5 cities in the Brazilian innovation ecosystem. For example, in the economic dimension of the Ranking of Competitiveness of Municipalities, Porto Alegre ranks 2nd; in the infrastructure dimension, the city ranks 5th. Additionally, challenges and opportunities are outlined. The use of this framework proved to be valid for this mapping, and thus, we consider this work a form of validation for the innovation ecosystem.

Keywords: Innovation; Innovation Ecosystem; Startup; Rio Grande do Sul; Porto Alegre.

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1 Introduction

Startups, also known as temporary organizations in search of a repeatable and scalable business model (Blank and Dorf, 2014), have been important drivers of economic and social transformation. These organizations, characterized by their agile and innovative approach to solving complex problems, are at the center of the contemporary innovation debate.

The startup movement fosters the development of several actors, such as investors, incubators, accelerators and support entities, which form the startup ecosystem. The area of innovation has been approaching ecosystems from different points of view, such as innovation ecosystems (Adner, 2006), entrepreneurship (Isenberg, 2016), platform ecosystems (Zen *et al.,* 2023), and business ecosystems (Moore, 1993).

The differences between these ecosystems may lie in their goal or in their object. For example, in the case of innovation ecosystems, the goal is to generate innovation as a whole, which can benefit the entire ecosystem (Adner, 2006; Gawer and Cusumano, 2014); in the case of a platform ecosystem, the expected benefit focuses on the platform, technology or large company that centralizes the ecosystem (Zen *et al.,* 2023).

For this work, we place the startup as the central element, that is, we use the approach that considers the actors who support the development of existing startups and work for the development of new startups. Previous works have already used this approach (StartupBlink, 2023, 2022, 2021). However, there is no widely accepted and considered concept to date.

Based on a literature review of different network innovation approaches (i.e., innovation ecosystem, entrepreneurial ecosystem and smart cities), the authors proposed a framework for the startup ecosystem. For this study, the startup ecosystem can be considered as an interconnected network of actors and resources that collectively support the growth and sustainability of these innovative companies. This dynamic environment includes not only startups, but also a variety of stakeholders, from providers of capital and specialized services to educational institutions as well as government policies.

This study aims to advance the understanding of the startup ecosystem in emerging countries, using the city of Porto Alegre (Brazil) as a reference through an approach that incorporates smart city frameworks (Abu-Rayash and Dincer, 2021), entrepreneurial ecosystems (Isenberg, 2016), and insights from the Pacto Alegre report (Pacto Alegre, 2019). The relevance of this research is highlighted by the fact that, although there is already a study by D'Andrea et al. (2023) about startup failure in the Porto Alegre entrepreneurial ecosystem, it focused exclusively on the dimensions of the entrepreneurial ecosystem proposed by Isenberg (2016). Our work differs by the fact that we add other reports and studies that use smart city concepts, as well as the specific dimensions of Pacto Alegre, complementing the study mentioned previously. Through the analysis of more than 20 reports on entrepreneurship, innovation, and startups in both the city and the state of Rio Grande do Sul, our investigation seeks to identify mechanisms for the success of startups in emerging ecosystems, as well as to examine the applicability of current theories and the possibility of developing new theoretical models that favor the success of startups. This approach significantly enriches the discussion on the topic, contributing to the existing literature with a broad and integrated perspective capable of highlighting strategic interventions and insights for the sustainable success of startups in ecosystems.

For this study, Porto Alegre city was chosen because it stands out as an important startup ecosystem. Therefore, this study aims to propose a framework to map the startup ecosystem in the city of Porto Alegre. This study analyses a series of data that indicate the city position in the national rank regarding startups. For example, Porto Alegre occupies the fifth place in the ranking of Emerging Ecosystems in Latin America (Startup Genome, 2023), and in the Brazilian Ecosystem; it ranks 11th in the Latin American Ecosystem (Startup Blink, 2023).

2 Literature Review

Startups are emerging organizations characterized by the relentless search for a scalable, recurrent, and profitable business model (Ries, 2011; Blank and Dorf, 2014). Ostermann, Nascimento and Zen (2021) complement this view, describing startups as nascent technology-based companies distinguished by their performance and highly innovative potential. It is important to note that startups generally emerge from an innovative idea or invention with significant market potential and face resource limitations (Dullius and Schaeffer, 2016).

Considering the startups evolutionary process, it is essential to understand their development and survival. As described by Blank and Dorf (2014), these organizations navigate a temporary trajectory, aiming to transform an innovative idea into a sustainable and impactful venture. For Feng *et al.* (2019), two dimensions are fundamental: the market dimension, involving understanding and adapting to market needs and dynamics, and the technology dimension, encompassing the ability to integrate, coordinate, and learn in the development of innovative solutions.

In addition to being recognized for their commercial innovation, startups play a prominent role in promoting the culture of innovation. They are vital agents in the constant evolution of innovation ecosystems, significantly contributing to market and social dynamics (Distrito and Instituto Caldeira, 2021).

Innovation ecosystems can be understood as interconnected networks, where different types of actors play varied roles (Dos Santos and Zen, 2022). These ecosystems encompass a diverse range of actors, including startups, large corporations, universities, research institutes, investors, incubators, accelerators, governmental bodies, and non-governmental organisations (Jackson, 2011). Each of these actors performs a unique role, contributing resources, knowledge, networks, and specific capabilities to the ecosystem (Adner and Kapoor, 2016). Thus, the ecosystem is seen as an interdependent community of heterogeneous participants, requiring effective governance, whether centralised or decentralised.

It is important to note that there are various types of innovation ecosystems, i.e., University Innovation Ecosystems (Etzkowitz, 2003), Platform Innovation Ecosystems (Gawer and Cusumano, 2014) and Entrepreneurial Ecosystems (Isenberg, 2010). The specificity of the type of Innovation Ecosystem indicates its focus, who the main actor is, and for which innovations are primarily targeted.

Nonetheless, regardless of the main actor, the spatial dimension is an important perspective within this approach (Jackson, 2011). Elements such as a distinctive atmosphere and shared values define and characterise ecosystems (Scaringella and Radzivon, 2018). Innovation in geographical contexts creates value that transcends the economic aspect, including social, environmental, and cultural impacts (Dos Santos and Zen, 2022). These aspects potentiate outcomes such as social commitment and economic development, contributing to the community's brand and social responsibility.

It is essential to understand that innovation ecosystems have different development phases, affecting their behaviour. Gomes *et al.* (2021) describe the onset of these ecosystems with the formation and emergence of collaboration opportunities. As more actors join and collaborations strengthen, the ecosystem enters a growth and consolidation phase (Autio, 2022). In maturity, ecosystems achieve an efficient operational state but must seek constant renewal to avoid stagnation and continue innovating as (Bogers *et al.,* 2019).

Innovation ecosystems are shaped by various essential factors, such as the diversity of actors (Jackson, 2011); resources like funding, infrastructure, and talent (Isenberg, 2010); the encouragement of experimentation and collaboration in the environment (Scaringella and Radzivon, 2018); knowledge and collaboration networks (Yaghmaie and Vanhaverbeke, 2019); and regulation and public policies (Isenberg, 2010). Therefore, the synergistic interaction between these factors not only defines the structure and dynamics of innovation ecosystems but also determines their ability to adapt and thrive in an ever-changing global environment.

It is possible to identify a convergence in the characteristics of the variables that permeate studies on entrepreneurial ecosystems and smart cities. As per the analysis of smart city literature conducted by Esashika, Masiero, and Mauger (2021), a smart city should include advanced information and communication technology (ICT), sustainability, an innovative and highly qualified society, high-tech governance with citizen participation, and a knowledge-based economy. These elements underpin the notion that a smart city promotes an innovative and qualified society aimed at developing the knowledge economy, using advanced ICT technologies to foster sustainability and participatory urban governance.

As Abu-Rayash and Dincer (2021) mention, the concept of a smart city encompasses eight main domains: environment, economy, society, governance, energy, infrastructure, transportation, and pandemic resilience. Each domain is assessed through key indicators, providing a comprehensive analysis that allows measuring a city's level of "smartness". Additionally, Camboim and Zawislak (2019) describe a smart city as an urban innovation ecosystem where knowledge flows easily from deliberate interaction and collaboration among different stakeholders, creating wealth supported by a flexible institutional structure, an integrated participatory governance model, a green digital infrastructure, and a functional urban design with diverse amenities, thus being essential for high quality of life and a prosperous environment for creativity and innovation.

However, as described in the multicase study conducted by D'Andrea *et al.* (2023) with ten entrepreneurs from the city of Porto Alegre, startups can fail in emerging entrepreneurial ecosystems. The research carried out by these authors indicates that, despite challenges in the domains of policy and financing, there is significant potential for improvements that could prevent premature startup failures. The analysis conducted by D'Andrea *et al.* (2023) was based on the six domains of Isenberg (2016) and highlights the need for a more robust and integrated entrepreneurial ecosystem capable of adequately supporting the development of startups. Among these areas are the need for more effective public policies and financing, improvements in the culture of support for entrepreneurship, and enhancements in market access. D'Andrea *et al.* (2023) research also points to the importance of strengthening human capital and institutional support, creating a more favourable environment for startup success.

Because of this, we adopted the same innovative ecosystem of the city of Porto Alegre for its strategic focus on promoting a culture of innovation and entrepreneurship (Pacto Alegre, 2019). The city, which hosts prestigious universities and a diverse and qualified population, adopts public-private initiatives like the Pacto Alegre to mobilise society,

government, academia, and businesses to create an environment conducive to startups. In particular, the Pacto Alegre initiative aims for the city to have more knowledge, social engagement, attractiveness for investments, better infrastructure conditions, friendliness towards entrepreneurs, cultural richness, cleanliness, and, most importantly, higher quality of life for its citizens (Pacto Alegre, 2019).

Considering the challenges identified by D'Andrea *et al.* (2023), we expanded the dimensions of analysis by comparing and incorporating the smart city variables from Abu-Rayash and Dincer (2021) and the variables developed by the Pacto Alegre (2019) with the dimensions of the entrepreneurial ecosystem by Isenberg (2016). To this end, we analysed secondary data in over 20 reports addressing the themes of innovation, entrepreneurship, and startups in the city of Porto Alegre and the state of Rio Grande do Sul. Our goal is to develop a framework that addresses the main dimensions and their variables to transform Porto Alegre into a "City for Startups" and improve its global reputation as a center of high-impact innovation and quality of life.

3 Methodological Procedures

In order to achieve the study objective, a framework-based review was conducted, following the guidelines indicated by Paul, Khatri and Duggal (2023). This approach uses predefined frameworks to structure the literature review, allowing for a systematic and organized analysis of existing studies. According to Paul and Rosado-Serrano (2019), review articles can be developed using a TCCM (Theories, Contexts, Characteristics, Methods) type framework, as it is a methodological tool designed to guide literature reviews in specific research areas. This framework includes four fundamental elements: (a) Theories, seeking the underlying theoretical bases of the study; (b) Contexts, considering the circumstances shaping the environment, such as geographical, economic, social, and cultural aspects, influencing the phenomenon of interest; (c) Characteristics, referring to the properties and interrelations of the studied constructs; and (d) Methods, covering the research strategies adopted, including study designs, sampling, and analytical tools. The TCCM allows for a comprehensive analysis, facilitating the identification of gaps, trends, and future research directions. This framework is beneficial for the development of this study, as it helps organise and synthesise knowledge in complex and multifaceted fields, significantly contributing to academic and practical advancement.

Aiming to explore the entrepreneurial ecosystem of Porto Alegre, we employed relevant theories such as entrepreneurial ecosystems (Isenberg, 2016), Smart Cities (Abu-Rayash and Dincer, 2021), and the innovation ecosystem mapping by Pacto Alegre (2019). Choosing Porto Alegre, located in southern Brazil as the context, reflects its significant role in the innovation and entrepreneurship scenario. The investigation is based on an in-depth analysis of secondary data collected from reports on the city of Porto Alegre and the state of Rio Grande do Sul. A series of reports were analyzed to extract data (Table 1). Data collected from the reports were analyzed to be presented by dimension, aiming to understand how these theories apply and interweave in the development of a robust and sustainable innovation ecosystem in the city, highlighting Porto Alegre's contribution to technological and entrepreneurial advancement in the Brazilian and global context.

Table 1 List of Analysed Reports for This Study

REPORT	AUTHORS	YEAR
State Competitiveness Ranking 2023	CLP	2023
Municipality Competitiveness Ranking 2023	CLP	2023
The Global Startup Ecosystem Report 2023	Startup Genome	2023
Global Startup Ecosystem Index 2023	StartupBlink	2023
Entrepreneurial City Index Brasil 2023	ENAP	2023
Fintech Report 2023	Distrito	2023
The Global Startup Ecosystem Report Fintech Edition 2022	Startup Genome	2022
Unicorn Race 2022	Distrito	2022
Mapping of the Brazilian Startups Ecosystem 2022	ABStartups	2022
State Competitiveness Ranking 2022	CLP	2022
Municipality Competitiveness Ranking 2022	CLP	2022
Overview of the use of the industrial property system by startups	Radar Tecnológico INPI	2021
RS TECH 2021	Distrito and Instituto Caldeira	2021
Artificial Intelligence Report 2021	Distrito	2021
Mapping of the Communities of the south 2020	ABStartups	2020
GAÚCHOTECH Mining Report 2019	Distrito	2019
Mapping of the Innovation Ecosystem of Porto Alegre	Pacto Alegre	2019
New ways for innovation in Brazil	Ipea	2018
Mapping of Startup Communities from Porto Alegre	ABStartups	2018
Mapping of Startup Communities from Caxias do Sul	ABStartups	2018
Mapping of digital Startups of Rio Grande do Sul	Sebrae	2016

Source: Authors' data 2024.

The combination of these literature was used to define which dimensions and key indicators should integrate a startup ecosystem. These studies highlight the importance of elements such as talents and knowledge, capital, institutional-legal structure, and interaction and quality of life, all essential to create an attractive environment conducive to innovative entrepreneurship. In this sense, eight dimensions were identified and analysed (sustainability, economy, society, human capital, infrastructure, support institutions, management and political-legal). The use of these dimensions is flexible and adaptable to the specific needs and characteristics of each city. Considering this, the framework created for the startup ecosystem of Porto Alegre had six dimensions: Sustainability, Economic, Society, Human Capital, Infrastructure and Political-Legal.

4 Results

Aiming to propose a framework to map the startup ecosystem in the city of Porto Alegre, this section will present the framework and data from the startup ecosystem in the city of Porto Alegre. The collected data was examined and grouped into six dimensions

from the literature: Sustainability, Economic, Society, Human Capital, Infrastructure and Political-Legal. Figure 1 illustrates Porto Alegre's startup ecosystem.

Each of the dimensions will be contextualized and the data will be presented and explored by dimension.

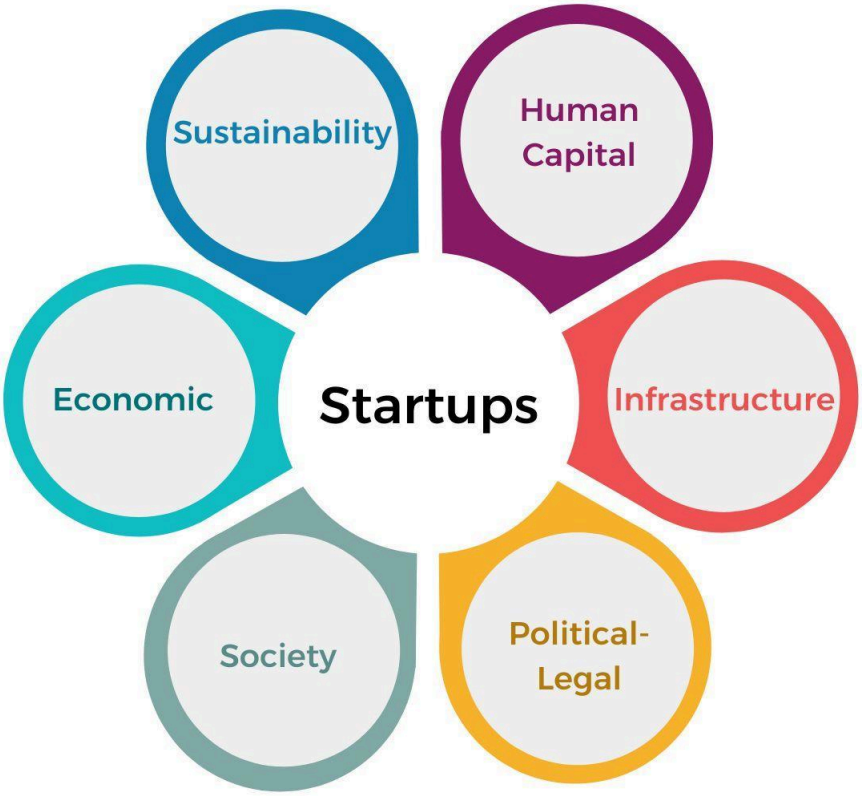

Figure 1 Startup Ecosystem of Porto Alegre.

4.1 Sustainability Dimension Indicators in Rio Grande do Sul

The State of Rio Grande do Sul has made significant advances in several areas in relation to sustainability and environmental management, as evidenced by its performance in the State Competitiveness Ranking (CLP, 2023a). See below the main indicators identified in this dimension.

- Ecosystem conversion: The State has demonstrated notable progress. In 2022, Rio Grande do Sul ranked 14th in Transparency in Actions to Combat Deforestation (CLP, 2023a). However, in 2023, it reached 1st place, demonstrating a strong commitment to transparency in its deforestation efforts (CLP, 2023a). Furthermore, the State occupies 4th position in the Speed of Deforestation category, indicating a considered and responsible approach to environmental concerns (CLP, 2023a).
- Waste management: This is another area where Rio Grande do Sul has stood out. The State occupies the 4th position in both Waste Recycling (Recovery of Recyclables)

and Selective Collection, according to the State Competitiveness Ranking (CLP, 2023a). These classifications reflect the State's adoption of effective strategies for reducing and recycling waste, contributing to a cleaner and more sustainable environment.

- Environmental sustainability: In the environmental sustainability dimension of the State Competitiveness Ranking (CLP, 2023a), the State of Rio Grande do Sul is in 9th position. This position reflects the State's ongoing efforts to balance economic growth with environmental preservation.

Regarding the Sustainability dimension, no specific data was obtained for the city of Porto Alegre, which makes it difficult to examine the city's startup ecosystem in detail. Therefore, only data from the State of Rio Grande do Sul were presented.

The State of Rio Grande do Sul has demonstrated a strong commitment to environmental and social sustainability, as evidenced by its performance in several categories of the State Competitiveness Ranking. These achievements are proof of the State's continuous effort to balance economic growth with environmental preservation and social inclusion.

4.2 Economic Dimension Indicators in Porto Alegre and Rio Grande do Sul

In the economic dimension of the Municipal Competitiveness Ranking (CLP, 2023b), Porto Alegre occupies an incredible 2nd position. This classification reflects the city's economic performance and competitiveness compared to other municipalities. However, the analysis of other indicators is also important to understand the context of the data above. The indicators that make up the economic dimension are listed below.

- Gross domestic product (GDP): Porto Alegre ranks 79th in terms of GDP per capita. This position, although not at the top, is still advantageous considering the total of 410 municipalities analyzed. However, there is room for improvement, as Rio Grande do Sul occupies the 2nd position in share of agribusiness GDP and 4th in share of the country's GDP (Distrito and Instituto Caldeira, 2021).
- R&D expenses as a % of GDP: Porto Alegre ranks 7th in R&D expenses as a percentage of GDP. However, the State of Rio Grande do Sul occupies the 23rd position in terms of Public Investments in R&D, according to the Municipal Competitiveness Ranking (CLP, 2023b). This suggests that the State could improve its position in this area.
- Patents filed: Rio Grande do Sul is the State with the highest number of patents filed for the second consecutive year (INPI, 2023; CLP, 2023a). Porto Alegre has also made progress, moving from 8th position in 2017 to 7th position in 2019 among the capitals with the most patents filed (Pacto Alegre, 2019; INPI, 2023).
- Computer program (software) deposited: In the software protection ranking, Porto Alegre occupies 7th position (Pacto Alegre, 2019). This indicates the city's strong presence in the technology industry.
- Financial capital: Porto Alegre ranks 5th in access to capital and went from 4th place in 2022 to 3rd place in credit per capita in 2023 (CLP, 2023b; ENAP, 2023). This suggests a healthy financial environment for businesses and individuals.

- Innovation: Porto Alegre is in 11th place in the Entrepreneurial Cities Index (ENAP, 2023), and the State of Rio Grande do Sul is in 1st place in the State Competitiveness Ranking (CLP, 2023a). This shows a strong focus on innovation both in the city of Porto Alegre and in the State as a whole.
- Startups and Innovative Enterprises: The State of Rio Grande do Sul ranked 1st for the second consecutive year in Innovative Ventures in the State Competitiveness Ranking (CLP, 2023a), and the city of Porto Alegre ranked 5th in the Competitiveness Ranking of Municipalities (CLP, 2023b). This indicates a thriving environment for innovative businesses.
- Economic Insertion: The State of Rio Grande do Sul occupies the 6th position in economic insertion according to the Competitiveness Ranking of States (CLP, 2023a), and Porto Alegre occupies the 36th position in the Competitiveness Ranking of Municipalities (CLP, 2023b). The State of Rio Grande do Sul ranks 2nd in Economic Insertion of Young People, according to the State Competitiveness Ranking (CLP, 2023a).
- Innovation and Economic Dynamism: Porto Alegre ranks 5th in Innovation and Economic Dynamism in the State Competitiveness Ranking (CLP, 2023a).

Furthermore, Porto Alegre occupies the 15th position in Economic Complexity in the State Competitiveness Ranking (CLP, 2023a) and is considered the 14th most entrepreneurial city according to the Entrepreneurial Cities Index (ENAP, 2023). The city's proximity to Mercosur countries also represents an advantage for the foreign market (Pacto Alegre, 2019). Although there are areas to be improved, the city and state have demonstrated a commitment to economic growth, innovation and competitiveness, and have performed strongly in the economic dimension.

4.3 Social Dimension Indicators in Porto Alegre and Rio Grande do Sul

In the social dimension, Porto Alegre occupies the 107th position among 410 municipalities according to the Municipal Competitiveness Ranking (CLP, 2023b). The social indicators identified in this study will be presented below.

- Human development index (HDI): Rio Grande do Sul moved from 6th to 5th position in the HDI, according to the State Competitiveness Ranking (CLP, 2023a). Porto Alegre has an HDI of 0.8%, above average, and occupies 28th position in the national ranking (Pacto Alegre, 2019).
- Unemployment Rate: The South Region has the lowest unemployment rate in Brazil, 4.7%. Rio Grande do Sul occupies the 13th position, compared to a total of 27 States, according to the State Competitiveness Ranking (CLP, 2023a). Porto Alegre's rate improved by 22.43%, going from 9.45% in 2018 to 7.33% in 2022, being one of the lowest among the capitals of the South and Southeast (Pacto Alegre, 2019; IBGE, 2023a; Prefeitura de Porto Alegre, 2023a).
- Income: Rio Grande do Sul ranks 6th in income inequality among 27 states, according to the State Competitiveness Ranking (CLP, 2023a).
- Poverty Index: Rio Grande do Sul ranks 2nd in the percentage of families below the poverty line, according to the State Competitiveness Ranking (CLP, 2023a).

- Health: Porto Alegre stands out among other capitals in the South and Southeast regions with 3,399 health institutions (Pacto Alegre, 2019). Furthermore, Porto Alegre had an increase from 9.3 doctors per 1,000 inhabitants in 2010, to 12.2 doctors in 2020 (Pacto Alegre, 2019; CFM, 2020).
- Creativity: Porto Alegre ranks 17th in Jobs in the Creative Sector for the 2nd consecutive year, according to the Municipal Competitiveness Ranking (CLP, 2023b).
- Security: The State of Rio Grande do Sul occupies 5th place in public security, 6th place in personal security and 10th place in property security according to the State Competitiveness Ranking (CLP,2023a).
- Social sustainability: In the social sustainability dimension of the State Competitiveness Ranking (CLP, 2023a), the State of Rio Grande do Sul is in 4th position. This classification indicates the State's commitment to ensuring that its growth and development strategies are socially inclusive and beneficial to the entire population, as it considers rates of racial balance and housing inadequacy.

It can be concluded that the city of Porto Alegre, as well as the State, is in a positive position in relation to the social dimension, particularly in relation to the HDI, creative sector and security. However, they present opportunities for improvement on certain fronts, such as in the social dimension of the municipalities' competitiveness ranking, allowing for a better positioning in relation to social aspects.

4.4 Human Capital Dimension Indicators in Porto Alegre

Porto Alegre presents significant achievements in human capital indicators, reflecting its commitment to education and work quality. See below the indicators identified in this dimension.

- Basic Education Development Index Number (IDEB): The IDEB of the Porto Alegre municipal education network in 2021 was low among the six capitals analysed in the South and Southeast regions, for the initial years. For the final years of elementary school, the city advanced from 7th position to 6th, when compared with the Pacto Alegre Report (2019), surpassing the index obtained by the city of Vitória, as shown in Table 2.

Table 2 – Basic Education Development Index

Capitals: South / Southeast	**Initial Years**	**Capitals: South / Southeast**	**Final Years**
1) Curitiba	6,0	1) Curitiba	5,3
2) Florianópolis	5,9	2) Belo Horizonte	5,2
3) Belo Horizonte	5,8	3) Florianópolis	5,2
4) São Paulo	5,7	4) São Paulo	5,1
5) Vitória	5,6	5) Rio de Janeiro	5,0
6) Rio de Janeiro	5,4	**6) Porto Alegre**	**4,8**
7) Porto Alegre	**5,2**	7) Vitória	4,6

Source: Authors' data based on INEP 2021 database.

- Educational Level of the Population and Percentage of the Population with Higher Education: Porto Alegre occupies the 3rd position among Brazilian capitals with 7.2% of its population having complete primary education. In terms of the percentage of inhabitants with complete secondary education, Porto Alegre is in 26th place, with 23.2% of its population. In relation to the percentage of the population with complete higher education or equivalent, Porto Alegre comes in 7th place with 27.4%, according to data from the National Quarterly Continuous Household Sample Survey (IBGE, 2023a). The city went from 3rd to 7th position among the capitals, when compared to the Pacto Alegre Report (2019), representing a percentage increase in the population with complete higher education of 4.4%. From Table 3 it can be seen that the city was behind Florianópolis (36%), Vitória (33.5%), Rio de Janeiro (29.3%), Brasília (28.3%), Curitiba (28. 3%) and Belo Horizonte (27.5%) but above São Paulo (26.7%).

Table 3 – Percentage of Population with Complete Higher Education

Brazil		**Population**	**Complete Higher Education**	**%**
		203.080.756	**29.243.629**	**14,4**
1	Florianópolis (SC)	537.211	193.396	36,0
2	Vitória (ES)	322.869	108.161	33,5
3	Rio de Janeiro (RJ)	6.211.223	1.819.888	29,3
4	Brasília (DF)	2.817.381	797.319	28,3
5	Curitiba (PR)	1.773.718	501.962	28,3
6	Belo Horizonte (MG)	2.315.560	636.779	27,5
7	**Porto Alegre (RS)**	**1.332.845**	**365.200**	**27,4**
8	São Paulo (SP)	11.451.999	3.057.684	26,7
9	Goiânia (GO)	1.437.366	363.654	25,3
10	Palmas (TO)	302.692	75.068	24,8

Source: Authors' data based on Censo-IBGE (2022) and IBGE (2023b).

- Number of Universities and University Centers: The city of Porto Alegre has 38 universities and university centers. This makes the city 5th among the capitals analysed in the South and Southeast regions, behind São Paulo (162), Rio de Janeiro (69), Curitiba (57) and Belo Horizonte (52), and ahead of Vitória (20) and Florianópolis (16), according to the INEP Higher Education Census (2022). The information demonstrates the important role of Porto Alegre as an educational hub in the country.
- Number of Stricto Sensu Postgraduate Programs: The number of stricto sensu postgraduate programs, including master's and doctoral programs, contribute to the development of skills and specialised knowledge in various areas (CAPES, 2023).
- Master's and Doctorate Scholarships: Rio Grande do Sul occupies 4th place in the State Competitiveness Ranking in relation to the number of scholarships to master's and doctorate courses (CLP, 2023a).

- Educational Assessment: Rio Grande do Sul showed notable progress in the Education Assessment indicator, moving from 9th to 1st place in 2023, as published by the State Competitiveness Ranking (CLP, 2023a).
- Access and Quality of Basic and Qualified Labour: According to the Entrepreneurial Cities Index (ENAP, 2023), Porto Alegre is positioned as the 4th city in terms of access and quality of basic and qualified labor, reflecting the city's efforts to maintain a qualified and competitive workforce.

The results obtained in these indicators highlight Porto Alegre's dedication to nurturing a robust ecosystem in terms of human capital, characterized by a qualified population, a strong educational infrastructure and a focus on improving the quality and accessibility of the workforce. These achievements position Porto Alegre as a significant contributor to the development of human capital in Brazil, promoting innovation, economic growth and sustainable development.

4.5 Infrastructure Dimension Indicators in Porto Alegre and Rio Grande do Sul

The infrastructure indicators highlight the State and the City's commitment to provide essential services, promote innovation and create an environment conducive to business growth and technological advancement. The indicators from Infrastructure Dimension will be presented below.

- Recovery of Degraded Areas: Rio Grande do Sul occupies 25th position in the Competitiveness Ranking of States in the recovery of degraded areas (CLP, 2023a).
- Access to Basic Sanitation - Water: Rio Grande do Sul ranks 5th for the 2nd consecutive year in access to treated water, reflecting the State's commitment to providing clean and safe water to its residents (CLP, 2023a).
- Quality of Highways: Rio Grande do Sul ranks 7th in the State Competitiveness Ranking (CLP, 2023a).
- Availability of Direct Flights: Rio Grande do Sul occupies 8th position in the State Competitiveness Ranking (CLP, 2023a).
- Accessibility of the Telecommunications Service: The State of Rio Grande do Sul ranks 4th in accessibility of the telecommunications service, with emphasis on the availability and quality of the telecommunications infrastructure (CLP, 2022a).
- Access and Quality of Electricity: Rio Grande do Sul ranks 5th in access to electricity, emphasizing the state's efforts to ensure reliable and widespread access to electricity (CLP, 2023a).
- Numbers of Innovation Environments: The metropolitan region and north coast of Rio Grande do Sul has a vibrant innovation ecosystem, with 22 Scientific, Technological and Innovation Institutions (ICTs), 15 incubators, 12 Technological Innovation Centers (NITs), 7 Technology Parks, 3 accelerators, 2 innovation centers, demonstrating a robust environment for technological and entrepreneurial development (SICT, 2023). Furthermore, in total, the state of Rio Grande do Sul has 47 incubators, 50 ICTs, 54 NITs, 20 Technology Parks, 5 accelerators and 4 innovation centers (Rede RS Startup, 2023; SICT, 2023).
- Porto Alegre Ecosystem Ranking: Porto Alegre occupies a prominent position in the startup ecosystem, being the 5th city in the Emerging Ecosystem of Latin America

(Startup Genome, 2022). Furthermore, it ranks 5th in the Brazilian Ecosystem, 11th in the Latin American Ecosystem and 14th in the Latin American and Caribbean Ecosystem (Startup Blink, 2023).

The data reflect the significant progress and potential of Rio Grande do Sul State and Porto Alegre City in building a robust infrastructure and an innovation ecosystem, contributing to economic development and regional technological advancement.

4.6 Political-Legal Dimension Indicators in Porto Alegre and Rio Grande do Sul

Porto Alegre, a city known for its active public sector and commitment to transparency, has made significant advances in several areas of public policy and innovation. The city occupies the 5th position among the 415 municipalities in the public sector services indicator, according to the Municipal Competitiveness Ranking (CLP, 2022b). In the scope of the provision of digital public services, the State of Rio Grande do Sul is recognized as a leader for the second consecutive year in the State Competitiveness Ranking (CLP, 2023a). This achievement highlights the State dedication to leveraging technology to improve public services and make them more accessible to its citizens.

The city ranks 22nd in municipal transparency according to the Municipal Competitiveness Ranking (CLP, 2022b). The State of Rio Grande do Sul occupies 4th place in information and communication in the State Competitiveness Ranking (CLP, 2023a). This demonstrates the city's commitment to effective governance and open communication with its citizens.

The political-legal indicators identified in this study will be presented below.

- Promotion of Innovation and Research: The Metropolitan Region and North Coast was the Inova RS region that received the most state funding for research. According to the Innovation Observatory of the Secretariat of Innovation, Science and Technology fed with data from the Rio Grande do Sul State Research Support Foundation (SICT, 2023). The amount of R$122.32 million was invested in 2023.

- Support for Entrepreneurship: Aiming at opening new businesses, the city has an entrepreneur's room and Tudo Fácil Empresas RS, a program created by the Government of Rio Grande do Sul involving several partners responsible for formalizing a company in 10 minutes (Prefeitura de Porto Alegre, 2023b). Porto Alegre was the first city in the State to adopt this system. The average time to open a business is an indicator that demonstrates how long it takes entrepreneurs to formalize their new business. Porto Alegre has an average business opening time of 63 hours, higher than the average for the capitals of the South and Southeast.

- Regulatory Environment: With regard to taxes, the minimum ISS rate is 2%, varying according to the service provided. Citizens of Porto Alegre can obtain assistance without leaving home through the Finance Services Portal, available 24 hours a day, every day of the week (Prefeitura de Porto Alegre, 2023c). Table 4 shows the percentage incidence of the ISS and IPTU rates on the Municipal GDP. Considering the 90 municipalities that make up the Metropolitan Region and North Coast, 19 cities have some regulatory initiative focused on the theme of innovation and entrepreneurship, according to a consultation carried out on the Municipal Laws platform. According to SEBRAE (2023), 54 cities have an Entrepreneur's Room.

Table 4 – Percentage of Incidence of the ISS and IPTU Rates on Municipal GDP

Capitals South/Southeast		Internal ISS Rate (% of City GDP)	Internal IPTU Rate (% of City GDP)
1	São Paulo	3,07%	1,75%
2	Belo Horizonte	1,97%	1,69%
3	Rio de Janeiro	1,89%	1,16%
4	Curitiba	1,82%	1,11%
5	**Porto Alegre**	**1,45%**	**1,10%**
6	Florianópolis	0,86%	0,70%
7	Vitória	2,47%	0,44%

Source: Authors' data based on ENAP (2023).

- Access to financing: Another way to promote innovation in companies is through promotion through legal mechanisms. In this sense, the average value of investments coming from the National Bank for Economic and Social Development - BNDES and the Studies and Projects Financier - FINEP per company in Porto Alegre is R$2,923.89. From Table 5 it can be seen that the city was behind São Paulo (R$32,640.93), Florianópolis (R$6,123.27), Belo Horizonte (R$5,159.22) and Rio de Janeiro (R$4,145.11) and above Curitiba (R$341.67) and Vitória ($220.84).

Table 5 – Average of investments

Capitals South / Southeast		Average of Investments from BNDES and FINEP Amount invested / companies (+)
1	São Paulo	R$ 32.640,93
2	Florianópolis	R$ 6.123,27
3	Belo Horizonte	R$ 5.159,22
4	Rio de Janeiro	R$ 4.145,11
5	**Porto Alegre**	**R$ 2.923,89**
6	Curitiba	R$ 341,67
7	Vitória	R$ 220,84

Source: Authors' data based on ENAP (2023).

Additionally, it is worth highlighting that the Pacto Alegre movement has currently 120 entities, 480 citizens involved and has already launched 40 projects for the city (Pacto Alegre, 2023). This is a testament to the city's collaborative approach to problem solving and innovation. This initiative brings together various stakeholders to work on projects that can benefit the city and its residents. Porto Alegre's effective public sector, the commitment to transparency and the innovative policies create a business-friendly environment and contribute to the city's economic growth and development.

5 Conclusions

This study aimed to propose a framework to map the startup ecosystem in the city of Porto Alegre. Through a framework-based review, a framework for startup ecosystems

was created with six dimensions: sustainability, economic, social, human capital, infrastructure, and political-legal.

The results show Porto Alegre as one of the top 5 cities in the Brazilian innovation ecosystem. For example, in the economic dimension of the Ranking of Competitiveness of Municipalities, Porto Alegre ranks 2nd; in the infrastructure dimension, the city ranks 5th.

Additionally, based on secondary data analysed, some challenges and opportunities were proposed to Porto Alegre, as follows.

Regarding the sustainability dimension, Porto Alegre can take advantage of Rio Grande do Sul's prominent position in sustainability to promote a favourable environment for the development of startups focused on sustainable solutions in the city. Porto Alegre also should establish partnerships with public and private organizations that share the same values and sustainability objectives, in order to boost the startup ecosystem in the city. Overcoming the lack of data related to sustainability specific to Porto Alegre is important, in order to identify areas for improvement and to establish clear goals and indicators for the development of sustainable startups in the city. Finally, it is also of paramount importance to ensure the availability of financial resources and political support for the implementation of programs and incentives that favour the growth and development of sustainable startups in Porto Alegre.

Regarding the economic dimension, Porto Alegre can compete with other startup ecosystems and innovative entrepreneurs in other municipalities and states, ensuring that economic growth and innovation are sustainable and inclusive, benefiting the entire population. Finally, it is important to align the efforts of the startup ecosystem with the needs and demands of the external market, taking advantage of the proximity to Mercosur countries.

Regarding the social dimension, Porto Alegre stands out in the creative sector and for having an HDI above average. These indicate an environment conducive to the development of startups. The prominence in the creative sector can be used to encourage innovation and entrepreneurship in this segment. It is observed that the State of Rio Grande do Sul is well positioned in relation to public, personal and property security, thus providing a safe environment for the installation and development of startups. From the other side, Porto Alegre occupies a relatively low position in the competitiveness ranking of municipalities, which indicates the need for improvements to boost the city's startup ecosystem. Improving the position in this ranking can attract more investments and resources to the startup ecosystem. Also, the State of Rio Grande do Sul has income inequality and a high percentage of families below the poverty line, which can limit access to resources for ecosystem development. Reducing income inequality and the percentage of families below the poverty line can be a challenge to provide a more inclusive environment for the development of startups. Finally, the city has a significant number of health institutions and a number of 12.2 doctors per 1,000 inhabitants, above the rate of 2.5 doctors per 1,000 inhabitants considered by the federal government as an ideal concentration of doctors (CFM, 2020), which can help promote innovation in this area.

Regarding the human capital dimension, although the State of Rio Grande do Sul is ranked 1st in Educational Assessment, Porto Alegre did not have a positive performance in relation to IDEB. In this sense, investment in basic education in the city is suggested in order to improve IDEB's performance. Considering Porto Alegre's positioning as the 4th city in access and quality of basic labour, it is suggested that the city benefits from this fact to promote qualified human capital. The fact that the city of Porto Alegre has 38 universities and university centers demonstrates the city's important role as an educational

hub in the country. Although Porto Alegre is among the main Brazilian cities in terms of population with completed higher education or equivalent, the city should take advantage of the fact that it has an educational hub to increase the percentage of the population with completed higher education. In general, Porto Alegre can be considered a talent-training city. In this sense, it is important to pay attention to the ecosystem so that qualified talent generated in the region is retained.

Regarding the infrastructure dimension, considering Porto Alegre's prominent position in the ranking of startup ecosystems, both at Brazilian and Latin American levels, added to the city's positive situation in relation to infrastructure, the city should focus on promoting innovation and the development of an environment conducive to business and technological growth. Also, strengthen collaboration between the actors that make up the region's innovation ecosystem to increase synergy and resource sharing. Finally, establish partnerships with private companies, universities and research centers to boost technological innovation and the growth of startups.

The indicators of the political-legal dimension analysis demonstrate Porto Alegre's effort to develop public policies, laws and regulations to encourage innovation and the growth of innovative entrepreneurship. By providing support, incentives and an enabling regulatory framework, these policies can contribute to a thriving innovation ecosystem and stimulate innovative entrepreneurship in the region or city. Also, authors suggest to increase the average value of investments for innovation, seeking partnerships with financial institutions. Finally, Porto Alegre's effective public sector, commitment to transparency and innovative policies create a conducive environment for business development, contributing to the city's growth and economic development.

In conclusion, it is important to highlight that the use of these dimensions is flexible and adaptable to the specific needs and characteristics of each city. There is no rigid formula or fixed number of dimensions to apply; cities can choose to implement a smaller number of dimensions or even group them in a way that best meets their particularities and objectives. This adaptive approach allows each startup ecosystem to develop a strategy that resonates with its unique context, maximising opportunities for success and growth.

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