

MAPPING INNOVATION AND ENTREPRENEURIAL ECOSYSTEMS AT CITY LEVEL: PROPOSITION OF A FRAMEWORK FOR ENGAGING ACTORS

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ABSTRACT

Entrepreneurial and innovation ecosystems (EIEs) in cities drive regional development. Thus, fostering EIEs is a priority for cities, policies and programs. In this paper, we argue that mapping and engagement of quadruple helix actors, i.e. academia, companies, government, and society, enhances collaboration, fostering urban innovation and entrepreneurship. For this investigation, we collected indicators and employed the Action Research (AR) approach, alongside Design Thinking (DT), in five workshops with 135 people from the quadruple helix in the EIE of Porto Alegre, Brazil. The indicators provided guidance for relevant issues, while workshops strengthened multilateral collaboration. Thereby, we propose a five-step framework based on AR and DT to map EIEs and to improve collaboration of quadruple helix actors in cities.

KEYWORDS: Entrepreneurial Ecosystem, Innovation Ecosystem, Quadruple Helix, Action Research, Design Thinking.

MAPEAMENTO DE ECOSISTEMAS DE INOVAÇÃO E EMPREENDEDORISMO EM NÍVEL LOCAL: PROPOSIÇÃO DE UM MODELO PARA O ENGAJAMENTO DE ATORES

RESUMO

Os ecossistemas de empreendedorismo e inovação (EIEs) impulsionam o desenvolvimento regional nas cidades. Assim, fomentar EIEs é uma prioridade para cidades, políticas e programas. Neste artigo, argumenta-se que mapear e engajar atores da hélice quádrupla - academia, empresas, governo e sociedade - fortalece a colaboração, promovendo inovação e empreendedorismo urbanos. Foram coletados indicadores e aplicou-se a Pesquisa-Ação (PA) e o Design Thinking (DT) em cinco *workshops* com 135 atores da hélice quádrupla do EIE de Porto Alegre, Brasil. Os indicadores orientaram questões relevantes, enquanto os *workshops* fortaleceram a colaboração multilateral. A partir disso, propõe-se um modelo de cinco etapas baseado em PA e DT para mapear EIEs e aprimorar a colaboração entre os atores da hélice quádrupla nas cidades.

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PALAVRAS-CHAVE: Ecosystema Empreendedor, Ecosystema de Inovação, Hélice Quádrupla, Pesquisa-Ação, Design Thinking.

MAPEO DE ECOSISTEMAS DE INNOVACIÓN Y EMPRENDIMIENTO A NIVEL LOCAL: PROPUESTA DE UN MODELO PARA LA PARTICIPACIÓN DE ACTORES

RESÚMEN

Los ecosistemas de emprendimiento e innovación (EEI) impulsan el desarrollo regional en las ciudades. Así, fomentar EEI es una prioridad para ciudades, políticas y programas. Argumentamos que mapear y comprometer a los actores de la hélice cuádruple - academia, empresas, gobierno y sociedad - fortalece la colaboración, promoviendo la innovación y el emprendimiento urbano. Recopilamos indicadores y aplicamos la Investigación-Acción (IA) y el Design Thinking (DT) en cinco workshops con 135 actores de la hélice cuádruple en el EEI de Porto Alegre, Brasil. Los indicadores guiaron temas relevantes, mientras que los workshops reforzaron la colaboración multilateral. Proponemos un modelo de cinco etapas basado en IA y DT para mapear EEI y mejorar la colaboración de los actores de la hélice cuádruple en las ciudades.

PALABRAS-CLAVE: Ecosistema Empreendedor, Ecosistema de Innovación, Hélice Quádruple, Investigación-Acción, Design Thinking.

INTRODUCTION

Ecosystems that promote innovation and entrepreneurship in cities have been recognized as a critical force behind regional development (Audretsch and Belitski, 2017). In order to access and conceptually clarify the sets of actors, institutions, social structures and cultural values that produce economic activity (Tsujiimoto et al. 2015), some authors have flexibly adopted the business, innovation and, most recently, entrepreneurial ecosystem metaphor (e.g. Adner, 2017; Adner and Kapoor 2010; Hakala et al., 2019).

The ecosystems in cities are gaining expression in order that citizens, companies, research centers and governments can develop collaborative solutions based on innovative products and services (Appio et al., 2019). To understand the ecosystems that promote entrepreneurship and innovation at the city level, we will use the innovation and entrepreneurship ecosystem approaches in this paper.

The ecosystem is the result of a complex environment in which different domains are involved and reinforced. Therefore, several individuals from companies, universities, government agencies, liaisons, and citizens can work together to generate innovations (Kristensson et al., 2004; Dahlander and Frederiksen, 2012). However, there is a lack of

theoretical basis to understand how and why co-creation among actors generates different value types in the simultaneous search for commercial and social value (De Silva and Wright, 2019).

Hence, we identified a gap in the literature regarding this process, especially in terms of engaging the quadruple helix of actors and mapping the ecosystem, focusing on identifying the local challenges and making the ecosystem in the city be able to generate and deliver value to all its stakeholders.

In this paper, we conducted the action research (AR) approach alongside a design thinking (DT) orientation to propose and apply a framework that enables engagement and collaboration between actors, thereby fostering the development of EIE in cities. We developed an AR in the city of Porto Alegre, Brazil, given that it is an emergent ecosystem with the necessary institutional and infrastructural conditions to support innovation. Porto Alegre started a movement for the improvement of its EIE through the joint efforts of academia, companies, government, and civil society. It is important to highlight that while the proposed approach may serve as a reference for other urban contexts, its full implementation requires a certain level of institutional maturity and path dependency in policies supporting innovation ecosystems (Martin and Sunley, 2006; Cloutier and Messeghem, 2021). In smaller cities or regions with weaker institutional frameworks, adaptations may be necessary to ensure feasibility and impact. The originality of this paper is the presentation of a framework to improve collaboration and to map the ecosystems in cities based on five steps.

ENTREPRENEURIAL AND INNOVATION ECOSYSTEMS IN CITIES

Cities can be understood as complex and multi-dimensional social actors, expressing themselves as they articulate public and private administrations, social and civic associations, academic and professional sectors as well as social media (Castells and Borja, 1996). In the context of this research, cities are not just physical areas where firms and individuals agglomerate and conduct economic activities; cities are networks formed through a complex set of overlapping relationships between different actors (Visnjic et. al., 2016).

Previous scholars argue that entrepreneurship and innovation occur from the interdependence between actors, the geographical proximity, the idiosyncratic nature, and the evolutionary dynamics of ecosystems (Stam, 2015; Spigel, 2017). The geographically bounded nature of a city ecosystem allows the agglomeration of actors (Martins et al., 2019). The proximity between them is an important feature in the ecosystem co-creation dynamics as it

encourages knowledge spillovers (Asheim, 2007) and promotes the concentration of tangible and intangible resources (Jacobides et al., 2018; Thomas et al., 2018), which are paramount in innovation processes.

Therefore, innovation and entrepreneurial ecosystems have non-linear and socially interactive dynamics (Acs et al., 2018; Stam, 2015). In such environments, actors are arranged in networks and interact in a complex way, competing but also cooperating (Shaw and Allen, 2016). Following this logic, they play complementary roles in co-creating value (Thomas et al., 2018) and can be classified according to the quadruple helix model (Carayannis and Campbell, 2009; Carayannis et al., 2018).

The quadruple helix model asserts that innovation is the outcome of the interplay between academia, government, companies, and society (Carayannis and Campbell, 2009). The city ecosystem must engage all the groups of actors in the creation of a clear (Thomas and Autio, 2020) and comprehensive value proposition (Walrave et al., 2018). The collaboration among them is a critical feature, given that it stimulates the creation, diffusion, and application of new knowledge, thereby resulting in new technologies, innovation, and ultimately leading to the creation of economic and social value that promotes regional development (Cavallini et al., 2016).

MAP, ANALYZE, AND DESIGN ECOSYSTEMS

To assess different elements of an ecosystem, we used different sources of information on indicators and databases. Indicators are usually used to support public policymakers' decisions, particularly those who have recently dedicated themselves to the development of ecosystems in cities and need to map their potential and design new policies to ensure scalability (Rapetti et al., 2023). There is no unique prescription for territorial development. In fact, territorial development requires tailored approaches that consider the specific context of each location (Karlsen and Larrea, 2016; Jeannerat and Crevoisier, 2022; Torre, 2025). Territories vary greatly depending on location. Thus, it is not possible to simply duplicate successful policies or even indicators.

Therefore, it is not feasible to evaluate the potential of a place based solely on numbers. Moreover, the literature adds countless difficulties when updating large data collections, and the lack of data of some measures makes it unreliable to present indicators that reflect some type of result that has social meaning (Gault, 2013). Hence, there is a need to employ other

methods for collecting relevant data, such as consulting experts for their opinion, so indicators can be complemented when data is scarce (Rapetti et al., 2023). Based on these arguments and the perception that there is no universal innovation policy available that fits all areas (Todling and Tripple, 2005; Torre, 2025), it is necessary to consider and learn about the differences between areas to achieve success (Ennals and Gustavsen, 1999).

We argue that ecosystem mapping should follow this same approach. Action research serves as a tool to facilitate engagement in territorial development, enabling researchers to collaborate with policymakers and other regional actors while contributing to knowledge generation and fostering a socially responsible and inclusive future for communities (Karlsen and Larrea, 2014; Scaramuzzi et al., 2023). Literature research can obscure the complexity and dilemmas that actors face in the territorial development processes, i.e., it does not show how and why actors become purposive, motivated, and enabled to promote the change in territories (Sotarauta and Pulkkinen, 2011). More “on-the-ground” policies can be developed if there is more information and knowledge available about contextual conditions, such as the need for actors to increase their competitiveness and potential for development (Asheim et al., 2007).

METHOD

We chose the approach of AR to propose and apply a framework for mapping EIE in cities and to engage the quadruple helix actors. As AR can produce theoretical insights and changes in practice, we believe this is the most suitable approach to justify our research. The AR enable the continued exploration of current issues related to innovation (Ollia and Ystrom, 2020), as it has the potential to generate new knowledge that is both useful and rigorous. The AR also fits with the territorial development approach, as it is a way of carrying out research in real-time with the participants in the process of change (Brydon-Miller et al., 2003).

The execution of this AR was carried out through four iterative steps: planning, acting, observing, and reflecting. First, planning is about the collection of the necessary data and planning the action to be performed to achieve the desired purpose. Second, acting is the moment when the action itself takes place alongside the care and constant observation of its results, thereby generating the data to feed the last step, reflecting, in which participants and researchers must understand what emerged from the action and, if necessary, change the process (Kemmis and McTaggart, 2007). This cycle repeats several times, as each cycle informs

successive cycles (Hill, 2014). These stages also often overlap, and the process is fluid, open, and responsive to contingencies rather than being linear or static (McTaggart et al., 2017).

We chose the ecosystem of the city of Porto Alegre (Brazil) due to its articulation between different actors to promote entrepreneurship and innovation. In 2018, the three biggest universities in Porto Alegre created the Alliance for Innovation with the support of the Porto Alegre City Hall. This alliance had the purpose of fostering the EIE of Porto Alegre. Among the projects of the Alliance for Innovation, the main one is Pacto Alegre, which seeks to engage the quadruple helix actors in a joint effort to create a more entrepreneurial and innovative city. The aim is to generate an innovative city with more knowledge generation, social cohesion, attractiveness for investors, better infrastructure, increased opportunities, encouragement for entrepreneurs, increased cultural diversity, eco-friendly/clean energy, and in particular, the creation of an improved quality of life for its citizens; then, the city can turn into a world-class EIE (Pacto Alegre, 2020). To do so, the first step was necessary to map, analyze, and design the EIE.

Then, we started AR to map the EIE activities. Hence, all the authors participated actively as the designers of this study. Moreover, all the participants of workshops were volunteers and contributed in representing the actors of quadruple helix. Based on our results, we proposed a framework to map other ecosystems.

BUILDING THE MAPPING FRAMEWORK

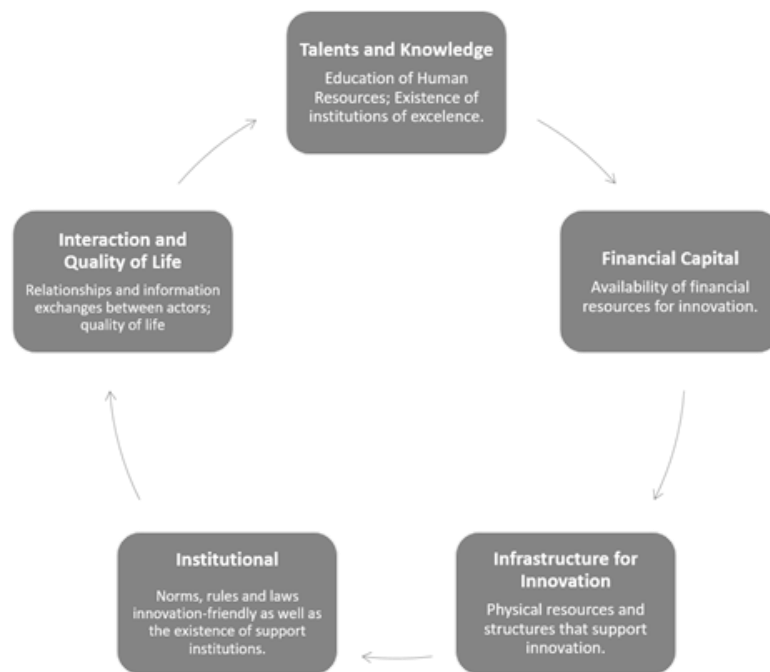
The Pacto Alegre and the movement of EIE of Porto Alegre started with a reunion among representatives from the three universities, the city hall, and an international consultant, who had already worked in similar projects in Barcelona (Spain), Medellín (Colombia), and Florianópolis (Brazil). This first meeting in April 2018 was attended by researchers, executives from science parks and incubators, technicians, secretaries, and directors from the city hall, as well as the mayor himself. The reunion set the schedule, structure, and macro-objectives for the project. One of the objectives of the project was to map the EIE of the city.

First Iterative Step

We started searching literature that could serve as a guide in understanding the dynamics and mapping the ecosystem of Porto Alegre. Then, we analyzed the dozens of papers and reports to propose an EIE model. These papers and reports included Endeavor (2017), Graham (2013), Isenberg (2011), Nicotra et al. (2018), Spigel (2017), and WEF (2013), which gave us

directions about the relevant elements to consider. After this activity, a model of five dimensions emerged (Figure 1): talents and knowledge, financial capital, infrastructure for innovation, institutional, and interaction and quality of life.

Figure 01: Dimensions of an EIE at city level



The dimension of talents and knowledge refers to the ecosystem's ability to train, attract, and retain highly qualified people (Florida, 2002), as well as to generate, absorb, and disseminate knowledge (Bathelt et al., 2004). Thus, cities with better education and a high level of human capital can be more innovative, creating and taking advantage of better opportunities (WEF, 2013), while not only reacting to, but also anticipating global challenges and trends. Metropolises, such as Porto Alegre, tend to present qualified universities, research centers, and large innovative companies that exploit the high concentration of talented professionals (Østergaard and Dalum, 2012).

The financial capital is another important attribute in an ecosystem (WEF, 2013), as it can foster innovation through funding and investment opportunities for the generation of knowledge (research), development of new technologies, and growth of innovative startups. High availability and easy access to financial resources can reduce the cost of innovation and allow innovative activities to occur more frequently (Kshetri, 2014), thereby generating jobs, income, and increasing citizens' welfare.

The structural dimension consists of the tangible presence of infrastructure and organizations that have an impact on its innovative potential. In this dimension, the existence of support services for entrepreneurs is mandatory (Spigel, 2017), as well as other structural resources, such as the existence of innovation areas and science parks, and appropriate transport, energy, telecommunications infrastructure, and logistics (Isenberg, 2011).

In turn, the institutional dimension consists of laws, regulations, habits, routines, and culture that support innovation in the ecosystem (Edquist, 2001). Policies that encourage innovation are required because institutions influence innovative activities within the ecosystem. Such policies should facilitate the dynamism, diversity, exploration of ideas, and creation of innovative startups (Isenberg, 2010). Moreover, a culture in which the actors share values, beliefs, and follow the same narrative, improves the odds of success for the ecosystem (Muñoz et al., 2020).

The interaction and quality of life dimension relates to the relationships and exchanges of information among the actors as well as the quality of life experienced by the citizens of Porto Alegre. This interaction helps in building networks and social capital, facilitating new learning, accessing opportunities, and obtaining resources (Spigel, 2017). Moreover, the cultural and contextual conditions that enable people to live better and happier influence citizens' well-being and perceived quality of life.

Second Iterative Step

Based on these dimensions of analysis, we carried out a research desk in 2018, based on data from the Internet, reports (such as Doing Business 2018, Global Innovation Index 2018, Global Entrepreneurship Monitor 2018), and research papers. The selected indexes and indicators should be reliable sources and allow us to compare with other ecosystems of cities around the world. Following that, the authors had several planned meetings with the executive group of Pacto Alegre. In these meetings, there were rounds of presentation and discussion of concepts and indexes.

The first task was to choose the labels to adopt for each dimension and to decide on the most relevant indicators to achieve our objective. As we collected data from more than 100 indicators, it would be unpracticable and inadequate to use all of them. In line with Karlsen and Larrea (2016), we understand that each territory must be analyzed according to its own characteristics. Thus, we selected the indicators that were the most relevant for the city.

Third Iterative Step

The third step was the collection of secondary data and indicators about the ecosystem of Porto Alegre, which was collected from official agencies, supporting institutions, and national and international reports. We conducted another round of discussions to present them. This round of discussions and feedback happened to better design and execute a method in which most people from academia, government, companies, and society could actively participate and represent their pairs. After the discussion, the group concluded that we did not have enough data to represent our reality and the data we had was not able to capture the complexity of our challenges, confirming what Gault (2013) had already highlighted.

In this way, we decided to carry out Design Thinking (DT) workshops, in which people from these quadruple helix actors could express themselves and interact with other groups of people in different roles, and with distinct views and perspectives. The decision to use DT is aligned with the contextual challenges and the intended objectives of this research (Kleinsmann et al., 2017). The DT is considered by many as a broad tool to solve complex problems (Kleinsmann et al., 2017) that can foster creativity and engage people in co-creation processes, thereby improving the likelihood of reaching outcomes such as better performance, innovation, and competitive advantage.

Fourth Iterative Step

The workshops started with a welcome coffee, then a 10-min warm-up activity, a 10-min presentation of the project, and finally a 5-min presentation on the dynamics of the meeting. In the second part, the chosen indicators were presented in 10-min, and then 5 min were set aside for the organization of the groups, which should have at least one member of each “helix”. The third part of the workshop was based entirely on the DT approach and included the use of the personas tool (fictional characters who represent profiles of real people) for reflection and discussion by the participants. The personas presented different profiles of Porto Alegre citizens.

The experts from the quadruple helix were invited to discuss and then present the strengths, weaknesses, threats, and opportunities (SWOT) of Porto Alegre’s ecosystem. This dynamic started with a silent 5-min brainstorming session and soon afterward, the participants went on to a collective brainstorming session lasting 15 min, which also involved the analysis of the ecosystem's strengths, weaknesses, opportunities, and threats concerning the situation

experienced by the persona. They also debated the main challenges arising from that perspective of analysis. For the next 10 min, each group compiled the data and had another 5 min to present it. The workshop ended with a general discussion of 30 min between all participants. With the consent of everyone who attended the workshop, the materials generated by the groups were collected by the researchers, and all the tasks were recorded by means of audio, photos, and videos for further analysis. The other workshops followed the same logic and brought about the reflections in the general sense.

Following each workshop, we summarized the results and triangulated the data with the secondary data and indexes collected from the reports for recommendations. Furthermore, a feedback session took place after each workshop, when the researchers debated the results and opportunities to improve the following rounds. An interesting finding was that, even if each workshop had a specific theme, the contributions from the discussions between the experts touched upon or even entered the competence of the other dimensions.

During the five workshops, we observed that people who were invited to participate actively shared their perceptions, actively heard and engaged in discussions with their pairs. Each workshop had more collaboration, diversity, and a high-energy environment (Bathelt et al., 2004). The structured approach of using dimensions and indicators in the workshops directly influenced the collaboration dynamics among quadruple helix actors. For example, discussions on financial capital revealed gaps in funding accessibility, leading to a stronger dialogue between startups and investors. The infrastructure dimension prompted universities and public institutions to explore partnerships for shared innovation spaces. By framing the discussions within these dimensions, the workshops facilitated an evidence-based debate that not only increased engagement but also led to concrete initiatives, such as joint policy recommendations and cross-sector collaborations

Table 1 presents the results of the mapping of each of the dimensions of the Porto Alegre EIE, as well as the main recommendations from each workshop.

Table 01: Results of the DT Workshops

Dimension	Key Indicators	Emergent categories	Main Recommendations
Talents and Knowledge	Basic Education Development Index Percentage of the population with higher education Number of universities Number of postgraduate programs Number of patents requested per year	Resources and Infrastructure Teaching Methodology Policies for Talents Educators' Motivation and Qualification.	Improve education strategies, focusing on E&I Disseminate good practices and methodologies for basic education Create a communication campaign for Porto Alegre Improve training, retention, and attraction of talents Disseminate E&I knowledge for researchers and entrepreneurs
Financial Capital	Federal investment in S&T per capita Number of accelerated startups Number of acceleration programs with investment. Number of investors Number of banks with microcredit lines	Credit and Funding Financial Support Policies for innovation and entrepreneurship Market Size	-Train and attract angel investors to the early stages of innovative ventures Publicize innovative businesses in the city to attract investors Develop and support open innovation programs Expand the dissemination of information about the process of opening new businesses
Infrastructure for Entrepreneurship and Innovation (E&I)	Number of Science Parks and Business Incubators. Number of Institutions to Support E&I Number of Startups Number of Innovation Centers	Urban Mobility Telecommunications Public-private partnerships Support for E&I.	Improve public transportation; Improve data and telecommunications infrastructure Inform the population about public transportation means schedule Develop long-term planning for E&I Improve the integration between public and private entities
Institutional Environmental	Municipal legislation to support innovation Tax incentives for innovation Time to open new businesses The average tax rate on services The average rate of the Urban Territorial Tax Number of innovation parliamentary fronts	Legislation to support E&I Tax Incentives for E&I Opening of New Business and Disputes in the Judiciary	Centralize support activities for entrepreneurship in a single location Simplify and publicize the process of opening and closing of companies Organizing a collective agenda for E&I events Disseminate initiatives of E&I Communication campaign about the city's attractions for investors and entrepreneurs
Interaction and Quality of Life	Human Development Index Unemployment rate Police occurrences Doctors per capita Number of international events per year	Safety Mobility Culture Technology.	Promote more cultural and social activities in public spaces Revitalization of public spaces Support civil society actions E&I spaces and collaborative environments Foster social businesses Identify and enhance local talent Attract large infrastructure projects

To assess the impact of these workshops, we primarily relied on qualitative feedback from participants, who shared their perceptions in post-workshop discussions and recorded video testimonials. These testimonials conveyed enthusiasm, optimism, and a strong sense of

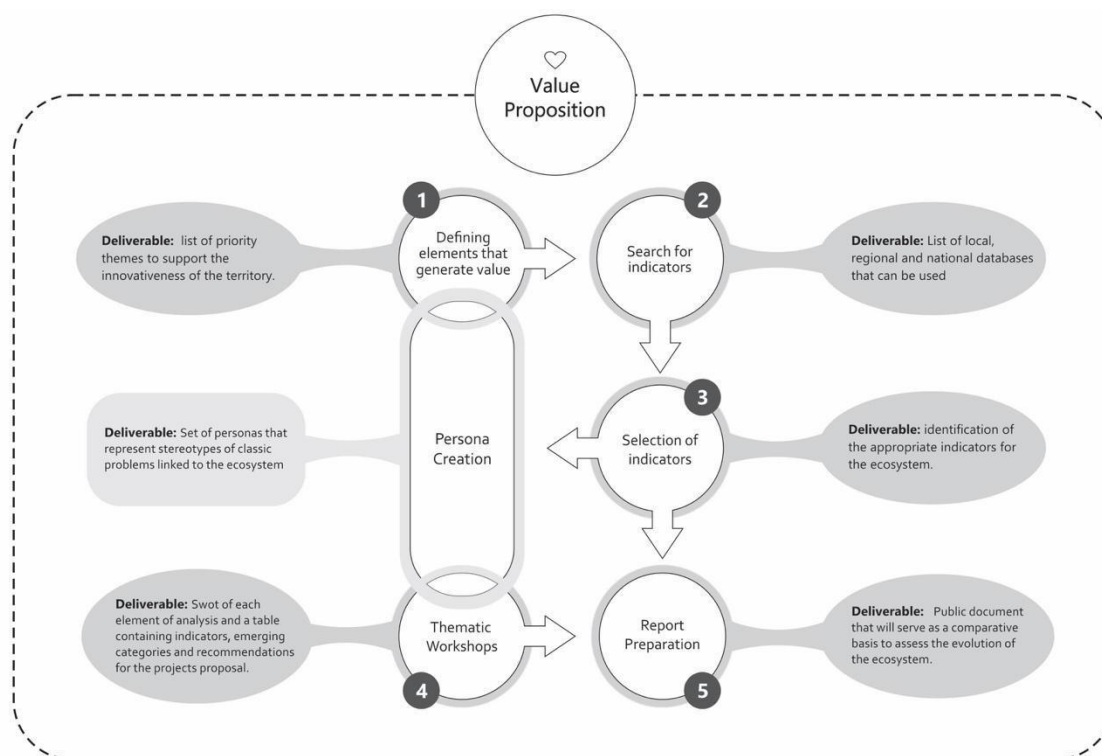
accomplishment, as participants felt heard and valued in the process of shaping the future of the city. Additionally, we analyzed the evolution of interactions throughout the workshops, identifying emerging collaborative networks and initiatives resulting from these sessions. This evaluation helped us understand how the workshops influenced the engagement of quadruple helix actors and their willingness to sustain long-term collaboration.

Thus, we can conclude that this was a pertinent approach, as its effects supported what was expected, i.e., open models of collaboration have the power to leverage the contribution of outsiders (Pisano and Verganti, 2008).

Fifth Iterative Step

As the sixth step, a report was delivered to the community; this document can elucidate the complexity and the relationship between the main challenges to design the transformation of the city. The main challenges identified for designing the ecosystem of Porto Alegre are related to urbanization, economy, social, and governance. These results show the steps behind the use of AR alongside DT strategies to build a method to map EIE through the engagement of quadruple helix.

The activities created to map the EIE, in the core of the Pacto Alegre project, not only provide us with the opportunity to map and improve collaboration in the ecosystem, but also to create a framework for other cities that have the desire to develop their own ecosystems. The proposed method for mapping and engaging actors from the quadruple helix in ecosystems in cities is composed of five iterative steps and is presented in Figure 2.

Figure 2: Five-step framework for mapping EIE in cities

After the mapping of the ecosystem, the challenges identified in the workshops were grouped into six GrandChallenges (Innovative City Image, Modernization of Public Administration, Quality of Life, Business Environment, Urban Transformation, and Education and Talents). To solve these challenges, 24 projects were selected and approved at the first working meeting of the Pacto Alegre's MESA (its deliberative instance), which took place in 2019, five of which were strategic and went into operation soon after (GauchaZH, 2019). The number of initiatives that emerged post-workshop, as well as their continuity in the subsequent phases of the Pacto Alegre provided practical evidences of the relevance of this framework, and brought valuable feedbacks that allowed us to refine it.

Pacto Alegre celebrated five years in 2024 and several initiatives developed through this initiative were directly influenced by the discussions held during the workshops, demonstrating the practical outcomes of the methodology. Among the main results, are the feasibility of the Caldeira Institute, in 2021, already one of the largest and most important innovation hubs in Brazil, which has more than 480 companies in its community, from startups to large public and private organizations (Época Negócios, 2024); the renovation of the Fourth District zone, once a degraded territory in the city of Porto Alegre, transforming it into a safe and receptive place for business and entertainment; the Porto Alegre's brand, a collaborative project that involved

a group of local designers in its elaboration and that was elected by 10000 citizens of Porto Alegre through popular vote (GauchaZH, 2023); South Summit Brazil, whose first edition was held in 2022 and has already consolidated it as one of the largest innovation events in the world, bringing together an average of 23 thousand people each edition in Porto Alegre (G1, 2025); the inclusion of Porto Alegre in the global Educating Cities program (AICE, 2025); and the “Morros do Futuro” Festival, which brought innovation to the periphery (Morros do Futuro, 2024); are some of the successful projects.

Porto Alegre also presents relevant results in relation to national and global indicators. Currently, is ranked as the 13th most promising city for startups in Latin America, and the fifth in Brazil (Startup Genome, 2024). In addition, Pacto Alegre has inspired state initiatives, such as Inova RS (a program of the Rio Grande do Sul state government whose objective is to foster the development of regional innovation ecosystems), positioning the state as the first place in innovation in Brazil (CLP, 2024).

Although the framework proposed in this study offers a structured approach to mapping and engaging actors in innovation ecosystems, its applicability is more robust in metropolitan areas with consolidated institutional environments and a history of collaboration among quadruple helix actors. Cities like Porto Alegre, which already had an articulated initiative such as Pacto Alegre, provide a fertile ground for such methodologies. In smaller municipalities or regions with fragmented governance structures, additional steps may be required to foster initial engagement and overcome institutional barriers. Future studies could explore tailored adaptations of this approach for medium-sized cities or regions with distinct political or cultural structures.

CONCLUSIONS

In this paper, we proposed and applied a framework for mapping EIE based on the AR approach and the DT strategies. Following the cycles of AR, that is, diagnosing, action, planning, action taking, evaluation, and learning (Ollila and Ystrom, 2020), and the adoption of DT, we identified five steps that could provide a comprehensive map with the improvement of actors' engagement and the appropriation of innovation culture and practices, thereby stimulating them to adopt an entrepreneurial behavior toward ecosystem improvement.

We contribute to the literature about how to promote engagement and collaboration between actors in an ecosystem (De Silva and Wright, 2019). With the case of Porto Alegre,

we also contribute to the underdeveloped approach of city ecosystems (Visnjic et. al., 2016). We used the AR and DT to promote the generation of new knowledge and the improvement of innovation processes (Kleinsmann et al., 2017; Ollila and Ystrom, 2020).

For practitioners, policymakers, and other stakeholders interested in fostering entrepreneurial and innovation ecosystems, this study also offers a detailed framework and provides guidelines to conduct a deliberate development process through innovation and collaboration. The results of the method application are context-dependent, further implying that it is difficult to intervene at the large-scale, thereby presenting the need for a case-by-case approach (Brydon-Miller et al., 2003). However, this approach could provide a deep understanding of the ecosystem in the level of the city. Further research should apply this method for mapping ecosystems in other contexts, particularly in small and medium-sized cities and regions with different governance and cultural structures. Given that the proposed framework relies on the availability of institutional support, financial resources, and engaged stakeholders, future studies could explore how to tailor its application to cities with less developed innovation ecosystems, identifying key enablers and barriers to its effective implementation

Additionally, future studies could further explore qualitative approaches to evaluating participatory methodologies, such as Design Thinking workshops. The testimonials and feedback collected in this study provided valuable insights into participants' engagement and motivation, while the success of post-workshop projects served as a tangible indicator of long-term impact. A deeper analysis of how these participatory initiatives translate into concrete urban transformation efforts could enhance our understanding of the effectiveness of collaborative innovation strategies. Moreover, the relationship between the individual, meso, and macro-level of the ecosystem is another avenue of research and could be considered in the analysis of the life cycle of the ecosystem.

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