UNIVERSIDADE FEDERAL DO RIO GRANDE DO SUL
ESCOLA DE ADMINISTRAÇÃO
PROGRAMA DE PÓS-GRADUAÇÃO EM ADMINISTRAÇÃO
DOUTORADO EM ADMINISTRAÇÃO

Diego Alex Gazaro dos Santos

PhD Dissertation

COORDINATION OF ACTORS AND RELATIONAL RESOURCES IN INNOVATION ECOSYSTEMS

Porto Alegre - RS

2022

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Dissertation presented as a final requirement for obtaining the title of PhD in Business Management, with emphasis on Innovation, Technology and Sustainability, at the Federal University of Rio Grande do Sul.

Advisor: Aurora Carneiro Zen, PhD.

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2022

CIP - Catalogação na Publicação

Santos, Diego Alex Gazaro dos
COORDINATION OF ACTORS AND RELATIONAL RESOURCES IN INNOVATION ECOSYSTEMS / Diego Alex Gazaro dos Santos. -- 2022.
141 f.
Orientadora: Aurora Carneiro Zen.

Tese (Doutorado) -- Universidade Federal do Rio Grande do Sul, Escola de Administração, Programa de Pós-Graduação em Administração, Porto Alegre, BR-RS, 2022.

1. Innovation Ecosystem. 2. Ecosystem Coordination. 3. Relational View. 4. Network Orchestration. 5. Resource Orchestration. I. Zen, Aurora Carneiro, orient. II. Título.

Elaborada pelo Sistema de Geração Automática de Ficha Catalográfica da UFRGS com os dados fornecidos pelo(a) autor(a).

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ACKNOWLEDGEMENT

I thank all my family, colleagues, friends and professors who helped me get here and gave me the strength to complete this important stage, especially my daughter Bela, my wife Ana Júlia, my mother Ângela, my father Paulo and my advisor Aurora.

Agradeço a todos os meus familiares, colegas, amigos e professores que me ajudaram a chegar até aqui e me deram forças para concluir essa importante etapa, em especial à minha filha Bela, minha esposa Ana Júlia, minha mãe Ângela, meu pai Paulo e minha orientadora Aurora.

This PhD dissertation received financial support from a research project supported by the State of Rio Grande do Sul Research Foundation (FAPERGS), and by a Sandwich Doctoral scholarship from the Coordination for the Improvement of Higher Education Personnel (CAPES) received by the researcher.

Esta tese de doutorado foi financiada em parte por recursos financeiros provenientes de projeto de pesquisa apoiado pela Fundação de Amparo à Pesquisa do Estado do Rio Grande do Sul (FAPERGS) e por bolsa de Doutorado Sanduíche da Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) recebida pelo pesquisador.

ABSTRACT

Today's most successful economies are no longer those based on goods, but rather on ideas and knowledge. Therefore, innovation becomes of paramount importance for regional and local development. Innovation ecosystems (IEs) stand out as environments with the objective of promoting innovation at firms, cities, and regions. These ecosystems go through different stages in their life cycle and must adopt strategies to coordinate the networks of interdependent and interrelated actors and resources that compose them, in order to be successful. Thus, innovation ecosystems can be analyzed from the perspective of the Resource-Based View (RBV). RBV highlights the rare, valuable, difficult to imitate and difficult to replace (VRIN) resources, as well as an implemented organization (O) that the firm must possess to achieve a sustainable competitive advantage (Barney, 1991; 1995). One of its main developments is the Relational View, which emphasizes that sustainable competitive advantage can result from relationships between a network of actors and considers the benefits jointly generated and owned by partnered actors (Dyer and Singh, 1998; Lavie, 2006). In the Relational View, the creation of value depends on four determinants: complementary resources and capabilities; specific assets of the relationship; knowledge sharing routines; and effective governance (Dyer, Singh and Hesterly, 2018). These partnerships are essential in innovation ecosystems, which consist of actors from Academia, Business, Government and Society, whose objective is to provide the means and conditions necessary to generate value through innovation. Thus, in a context of uncertainty and diffuse interests, the coordination of actors and relational resources can generate value and innovation, resulting, consequently, in better performance and competitive advantage for the actors and the ecosystem itself. This research contributes to the literature by exploring ecosystem dynamics and the role of the coordination of actors and relational resources in creating sustainable competitive advantage, thus contributing to regional development. As main results, we proposed a method for mapping, analyzing, and designing IEs in cities, a framework for analyzing the orchestration of actors and resources in innovation ecosystems, and we found that each stage of an IE's life cycle – inception, launching, growth and maturity – demands different coordination strategies – governance, orchestration, multiple orchestration or choreography. These results can serve as a guide for policymakers, managers and other ecosystem leaders interested in fostering innovation.

Keywords: Innovation Ecosystem; Ecosystem Coordination; Relational View; Network Orchestration; Resource Orchestration.

RESUMO

As economias mais bem sucedidas de hoje não são mais aquelas baseadas em bens, mas sim em ideias e conhecimento. Portanto, a inovação torna-se de suma importância para o desenvolvimento regional e local. Os ecossistemas de inovação (EIs) se destacam como ambientes com o objetivo de promover a inovação nas empresas, cidades e regiões. Esses EIs passam por diferentes estágios em seu ciclo de vida e devem adotar estratégias de coordenação dos atores e recursos interdependentes e interrelacionados que os compõem, de modo a serem bem sucedidos. Assim, os EIs podem ser analisados por meio da Visão Baseada em Recursos (VBR). A VBR destaca os recursos valiosos, raros, difíceis de imitar e difíceis de substituir (VRIN), bem como sua organização (O) para a obtenção de vantagem competitiva sustentável (Barney, 1991; 1995). Um dos principais desenvolvimentos da VBR é a Visão Relacional, a qual argumenta que a vantagem competitiva sustentável pode resultar de relações entre uma rede de atores e considera os benefícios gerados conjuntamente e de propriedade de atores parceiros (Dyer e Singh, 1998; Lavie, 2006). Na Visão Relacional, a criação de valor depende de quatro determinantes: recursos e capacidades complementares; ativos específicos da relação; rotinas de compartilhamento de conhecimento; e governança eficaz (Dyer, Singh, e Hesterly, 2018). Essas parcerias são essenciais nos EIs, compostos por atores da academia, empresas, governo e sociedade, cujo objetivo é fornecer os meios e condições necessários para gerar valor por meio da inovação. Assim, em um contexto de incerteza e interesses difusos, a coordenação de atores e recursos relacionais pode gerar valor e inovação, resultando, consequentemente, em melhor desempenho e vantagem competitiva para os atores e o próprio ecossistema. Esta pesquisa contribui para a literatura explorando a dinâmica dos EIs e o papel da coordenação dos atores e recursos relacionais na criação de vantagem competitiva sustentável, contribuindo assim para o desenvolvimento local e regional. Como principais resultados, são propostos um método de mapeamento, análise e desenho de EIs nas cidades, um *framework* para analisar a orquestração de atores e recursos em ecossistemas de inovação, e o achado de que cada estágio do ciclo de vida de um EI – início, lançamento, crescimento e maturidade – exige diferentes estratégias de coordenação – governança, orquestração, orquestração múltipla ou coreografia. Esses resultados podem servir de guia para formuladores de políticas públicas, gestores e outros líderes dos EIs interessados em fomentar a inovação.

Palavras-chave: Ecossistema de Inovação; Coordenação do Ecossistema; Visão Relacional; Orquestração de Rede; Orquestração de Recursos.

LIST OF ILLUSTRATIONS

LIST OF ABBREVIATIONS AND ACRONYMS

AR	Action Research
BRIC	Brazil, Russia, India, and China
DT	Design Thinking
GDP	Gross Domestic Product
GII	Global Innovation Index
IBGE	Brazilian Institute of Geography and Economy
IE	Innovation Ecosystem
LA	Latin America
PUCRS	Pontifical Catholic University of Rio Grande do Sul
QH	Quadruple helix
RBV	Resource-based View
R&D	Research and Development
SCA	Sustainable Competitive Advantage
SWOT	Strenghts, Weaknesses, Opportunities, and Threats
TH	Triple helix
TIC	Information and Communication Technology
UFRGS	Federal University of Rio Grande do Sul
UNISINOS	University of Vale do Rio dos Sinos
WEF	World Economic Forum

SUMMARY

1. INTRODUCTION

The most successful economies today are no longer those based on goods, but on ideas and knowledge (Florida, 2012; Acs, Zerb, and Autio, 2015). These are inputs for innovation, the driving force of development (Schumpeter, 1985). Innovation has the potential for improving employment, income and social well-being in a territory, but for this to happen successfully, an innovation ecosystem (IE) must be nurtured and coordinated. Hence, innovation ecosystems bring together the actors and resources necessary for the innovative process to take place. Fostering IEs and properly coordinating them are one of the most important strategies for local and regional socioeconomic development.

Innovation ecosystems can be defined as the result of the interaction between multiple networks of actors, encompassing both the resources and the dynamics of cooperation, competition and relationships between them. Territorial IEs are open, dynamic and geographically bounded environments (Rabelo and Bernus, 2015), permeated by cyclical flows of tangible resources - such as human and financial - and intangible resources - such as information - whose actors, structured in networks, interact in a complex way, competing, but also cooperating and sharing resources with each other to co-create value and innovate (Shaw and Allen, 2018). Therefore, these ecosystems are composed of a set of actors, resources and processes that, together, promote innovation in a given location.

The Resource Based View (RBV) can contribute to the explanation of this phenomenon. The RBV considers the firm as a group of complementary resources (Wernerfelt, 1984), which allow it to obtain superior performance (Barney and Clark, 2007) and competitive advantage (Barney, 1991; Zen and Fracasso, 2011). This theory has become one of the most prominent in the field of strategy, being used to explain phenomena even beyond the firm's borders, such as the benefits arising from cooperation and involvement in networks, focus of analysis from the relational perspective (Dyer and Singh, 1998). In the Relational View, actors form partnerships to create and capture value from complementary resources, enjoying network benefits (Dyer, Singh, and Hesterly, 2018).

However, the mere existence of resources is no guarantee of success. Innovation Ecosystems must be coordinated. Furthermore, innovation ecosystems are evolutionary and go through different stages of maturity in their life cycle, with each of these stages - Inception, Launch, Growth, and Maturity (Piqué et al., 2019) - requiring a specific coordination strategy for the effective exploitation of their potential and evolution to the next stage. The strategies

employed to coordinate the complementarities and flow of resources in an innovation ecosystem, such as orchestration (Dhanaraj and Parkhe 2006) and choreography (Ferraro and Iovanella, 2015) can increase the performance of IEs (Walrave et al., 2018). If coordination within the ecosystem is inadequate, innovations will fail (Jacobides et al., 2018). Therefore, the coordination strategies of actors and relational resources employed in each ecosystem's life cycle stage are paramount for the full realization of its potential.

Analyzing the coordination strategies of actors and relational resources adopted for each life cycle stage of an innovation ecosystem and considers that network structures and external relations are essential to the transfer of knowledge (Boari and Lipparini, 1999) and, consequently, to innovation (Fernandes et al., 2017). Thus, relational resources can generate competitive advantage in an innovation ecosystem as long as the relational resources are identified and an effective coordination strategy for each stage of the ecosystem's life cycle is adopted to mobilize and exploit these resources through a collective strategy, shared by its actors.

In this dissertation, we take the approach of innovation ecosystems in cities, as cities are increasingly the main centers where innovation takes place and, therefore, are of utmost importance for socioeconomic development. The innovation activity, previously confined to specific and closed environments, such as universities, companies, incubators and technology parks, is now becoming open and flowing in an organic way within city limits, influenced by factors such as proximity, density, variety of people and firms, and new technologies, facilitating the use of benefits arising from the agglomeration of actors (Mulas, Minges, and Applebaum, 2016).

In emerging countries, the city-level approach to innovation ecosystems is especially relevant due to its potential to stimulate scientific and technological advances, enabling greater socioeconomic development. Population density makes urban environments responsible for two-thirds of all growth due to cross-pollination of ideas. Doubling the size of a city can increase the income, wealth and innovation it produces by up to 15 percent (Diamandis and Kotler, 2020). Therefore, this PhD dissertation explores the coordination strategies of actors and relational resources for the process of developing innovation ecosystems at the city level according to its life cycle stages. This research can contribute to this topic, based on the need to overcome economic and social challenges through innovation.

1.1 RESEARCH PROBLEM

Currently, competition extends beyond the limits of individual or specific organizations and reaches the territorial level, between different ecosystems (Cennamo and Santalo, 2019), thus demanding the construction of local and regional advantages from the gathering of distinct but complementary knowledge (Asheim, Boschma, and Cooke, 2011). The spread of knowledge among actors is enhanced by their geographic agglomeration and it can boost innovation, contributing to the solution of the complex challenges faced by cities in meeting their socioeconomic development goals and quality of life. Therefore, cities and urban areas are considered not only as objects of innovation, but also as innovation ecosystems, strengthening collective intelligence and co-creation capacities among actors (Schaffers et al., 2011).

In face of this scenario, innovation is becoming urban and city-level innovation ecosystems are emerging, making the development of innovation ecosystems an increasingly adopted strategy by public authorities. Cities that have implemented programs to improve their innovation ecosystems, such as Amsterdam, Barcelona, Helsinki and New York, have discovered that these ecosystems are based on connections and diversity of actors, which play a key role in their functioning and in their dynamics of growth (Mulas, Minges, and Applebaum, 2016).

However, innovation ecosystems do not grow at the same pace in all cities, as cities have different potentials (Camboim, Zawislak, and Pufal, 2019) and the development of an ecosystem is usually complex and gradual, resulting from a long period of time and a process of continuous evolution adapted to contextual conditions (Rabelo and Bernus, 2015). Hence, some cities experience greater, faster and more sustainable growth than others, resulting in a greater number of new businesses, investment, employment and, consequently, quality of life and economic growth.

Besides, it is not yet clear which elements cause different growth rates. In addition to public policies (Mulas, Minges, and Applebaum, 2016), other factors also influence the response to the challenges that arise in this context (Walrave et al., 2018). Therefore, it is necessary to understand – from a dynamic perspective, considering the ecosystem's life cycle stages – how innovation ecosystems evolve over time, adapt to new contextual configurations (Spigel, 2017), what these elements are and how the dynamics occur so that they can be coordinated in an integrated and comprehensive way (Camboim, Zawislak, and Pufal, 2019), contributing for the ecosystem to achieve superior performance and obtain sustainable

competitive advantage. Therefore, associating the coordination of actors and resources with the life cycle of innovation ecosystems is an opportunity to advance these literatures.

The innovation ecosystem approach has emerged promisingly in the literature on strategy, innovation and entrepreneurship. However, it remains focused mainly on what they are and how they operate, thus lacking further progress. Theory development relies heavily on some seminal work, but both empirical and conceptual advances are needed before a coherent theory of ecosystems can emerge (Suominen et al., 2018; Wurth, Stam, and Spigel, 2021). In addition, the cause-and-effect relationships between the elements of an ecosystem still need to be studied (Nicotra et al., 2017; Stam and Spiegel, 2017) and, although the literature emphasizes the evolution and dynamicity aspects of ecosystems, it still predominates a static point of view about them (Alvedalen and Boschma, 2017), which disregards their evolution over time (Cavallo, Ghezzi, and Balocco, 2019).

Thus, the area of innovation ecosystems, even though it developed quickly and generated a wide range of literature, is still relatively new and needs more clarity in relation to several aspects (Shaw and Allen, 2016; Adner, 2017). Among the gaps to be analyzed are the definition of the term "innovation ecosystem" and some other questions on which there is still no consensus, namely: what are the actors and strategic resources of an innovation ecosystem? What are the dynamics of relationships between actors in an innovation ecosystem? What are the specific relational resources that are established in the ecosystem? What is the role of coordination of actors and resources in an innovation ecosystem in order for the to be managed? How ecosystems evolve over time and how coordination drives this evolution? These questions can be answered by analyzing the coordination strategies of actors and resources through the life cycle stages of an innovation ecosystem. Therefore, the central question of this research is **how does the coordination of actors and relational resources occur in innovation ecosystems?**

1.2 OBJECTIVES

The objectives of the present doctoral dissertation are presented next.

1.2.1 General Objective

To analyze how actors and relational resources are coordinated in innovation ecosystems.

1.2.2 Specific Objectives

a) Identify the main actors and resources of an innovation ecosystem;
b) Propose a classification of relational resources in innovation ecosystems;
c) Understand the process of orchestrating actors and resources in innovation ecosystems;
d) Develop a dynamic framework for actor's coordination in innovation ecosystems.

1.3 JUSTIFICATION

Fostering innovation ecosystems in cities represents an opportunity for developed and emerging countries, as they result in new jobs and more competitiveness, which are key to poverty reduction, increased social well-being and economic growth. In Latin America (LA), especially, where approximately 80% of the population lives in urban centers, the focus on generating innovation from a collective strategy and the resources shared by local actors can be a differential in the search to achieve patterns of development and social well-being close to those of more prosperous regions (Mulas, Minges, and Applebaum, 2016). Brazil has great potential to advance in this field of knowledge, given its pioneering in hosting the first technology park and the first incubator of high-tech companies, and possibly having the most developed innovation ecosystem in the region (Oliveira Jr., Cahen, and Borini, 2019a). Moreover, innovation is already highlighted as one of the country's strategic priorities.

According to the National Strategy of Science, Technology and Innovation (CGEE, 2021), the sustainable development of Brazil involves stimulating collaboration between public and private entities inserted in innovation ecosystems. The articulation between research and technological development to meet the demands of companies and solving society problems faced by diverse communities throughout the country, is an essential and indispensable means to promote inclusion and contribute to a more prosperous Brazil. Thus, this research contributes to the national strategy of Science, Technology and Innovation, aimed at boosting the sustainable development of the country. This strategy is based on the consolidation of a paradigm of collaborative innovation in Brazil, through the strengthening of links between

universities, companies, government and society, to solve major social, environmental and economic challenges (Brasil, 2021) and solidification of the bases of development.

Additionally, this dissertation can also help in the promotion of public policies for the development of innovation ecosystems contextualized to the Brazilian reality, benefiting the population, with short-term results (from one to three years), but also considering the sustainability of the proposed actions in a broader scenario, with medium and long-term benefits. Among the benefits may be the understanding of a more effective and efficient way to promote the creation of innovation ecosystems, helping to understand how local actors and relational resources can be coordinated, in order to optimize collaboration between the first and the better exploitation of the latter (Mulas, Minges, and Applebaum, 2016).

Therefore, fostering innovation ecosystems can be a strategic focus of public policies, since sustainable development is a priority for Brazil and innovation is fundamental for this goal to be achieved. Currently, however, the country's performance in international rankings is unsatisfactory. In the Global Innovation Index 2018 (GII 2018), Brazil ranks 57th out of 132 countries analyzed and ranks fourth in Latin America, behind Chile, Costa Rica, and Mexico. Among the main points of improvement are institutions, infrastructure and market sophistication, in which the country is in 78th, 69th, and 75th position respectively (WIPO, 2021).

One of the positive aspects highlighted by the ranking (GII) is that Brazil is a reference in Research and Development (R&D) expenditure. Brazil is the first place in Latin America in relation to this issue, investing above one percent of its GDP in R&D projects, which is comparable to some European economies, such as Croatia and Luxembourg. This way, the country is making advances and presents and overperformance in this ranking for the first time ever (WIPO, 2021). Moreover, it emphasizes the potential of science and technology in Brazil as well as the need to keep improving and to value for its products thus generating innovation.

Brazil also presents opportunities for improving entrepreneurship levels. In the Global Entrepreneurship Index 2019 ranking, the country ranks 118th out of 137 countries analyzed. Its greatest strength, according to the report, are the networks of relationships between entrepreneurs, while the internationalization of new businesses is the area in which the country most lacks evolution (Acs et al., 2019). Similarly, Brazil also appears as the least competitive country among the BRICs (group of the emerging countries Brazil, Russia, India, and China) in the World Bank Global Competitiveness Report. In the overall ranking, it is ranked 72nd out of 140 countries. Its macroeconomic context is described as "volatile" and the market considered "relatively closed" (Schwab and Zahidi, 2020).

Finally, in the Doing Business 2020 report, Brazil also appears below the overall average. Despite having shown the evolution due to reforms made in the business environment, especially regarding starting a business and registering property, the country is 124th out of 190 economies (The World Bank, 2020a).

Thus, Brazil needs to evolve in relation to its global competitiveness, especially in issues related to entrepreneurship and innovation, central elements for the development of the country and that directly influence the quality of life and social well-being of the population. As the World Economic Forum (Schwab and Zahidi, 2020) points out, the country has much to gain by fostering innovation.

Comprising one of the main innovation ecosystems in Brazil, Porto Alegre, in Rio Grande do Sul, highlights significant importance to this strategy as a pillar for its development. In April 2018, the Innovation Alliance was created, an articulation between the three main local universities, with the purpose of developing actions that make Porto Alegre more innovative (UFRGS, 2018). The main project of the Alliance for Innovation is the Pacto Alegre, an initiative that brings together the universities, municipal government, companies and civil society, and aims to transform the city into an international reference in innovation (Zen et al., 2019).

Hence, there is relevant opportunity identified for this study, especially if we seek to better understand the development strategies of innovation ecosystems in emerging economies, such as Brazil. An effective coordination strategy for actors and resources can drive innovation ecosystems to obtain sustainable competitive advantage.

As theoretical contributions, it seeks to advance knowledge about the field of strategy (Makadok, Burton, and Barney, 2018), as well as expand the application of RBV, offering insights regarding the orchestration of resources in the ecosystem and the influence on the performance of actors and the ecosystem itself. Thus, ecosystems incorporate value creation beyond the firm, responding to the criticism and research opportunity proposed by Priem, Butler and Li (2013), which point to the need to consider value creation for all stakeholders.

This research opportunity follows the finding that the greatest theoretical contributions in strategic management expand, clarify, apply or combine existing theories in new and timely ways. It is also possible to make unprecedented theoretical contributions from levels of analysis higher than that of the firm – such as ecosystems. With careful adaptation and appropriate adjustments, some elements of a theory at one level of analysis may be at least partially relevant at other levels of analysis (Makadok, Burton, and Barney, 2018). Thus, it is relevant the

application of RBV to innovation ecosystems, because such adaptations are opportunities to extend the theory.

Therefore, the association between RBV and coordination strategies, such as orchestration, in innovation ecosystems represents a new combination, a new level of analysis and a new field of application for RBV, with significant potential for advances in strategy literature. Considering a context with diffuse interests, such as innovation ecosystems, with actors competing and cooperating at the same time, the orchestration of strategic resources can influence their effective mobilization and exploration through a collective strategy, resulting in competitive advantage for the actors, as well as superior performance for the ecosystem.

In view of the relevance of innovation ecosystems for socioeconomic development, this research has theoretical contributions especially for the context of cities in emerging countries, such as Brazil. Thus, this doctoral dissertation seeks to advance the literature, specifically addressing, through four papers, the development of innovation ecosystems through coordination strategies of actors and relational resources.

1.4 STRUCTURE OF THE DISSERTATION

This PhD dissertation is organized in the form of papers. Therefore, to meet the intended objectives, four articles were developed, entitled "Mapping, Analyzing and Designing Innovation Ecosystems in Cities: An Action Research Approach", "Orchestration of Actors and Resources in Innovation Ecosystems", "Orchestration of Actors and Resources in Innovation Ecosystems: an empirical perspective", and "From Governance to Choreography: Coordination of Innovation Ecosystems", respectively.

The **first paper**, called **"Mapping, Analyzing and Designing Innovation Ecosystems in Cities: An Action Research Approach"** argues that the deliberate actions towards the development of an IE should start by the engagement of the quadruple helix actors and the mapping of the IE, focusing on identifying the local challenges and making the IE able to generate and deliver value to all of its stakeholders. The coordination strategies for innovation ecosystems should encompass the design, planning and management of activities (Gomes et al., 2021) and resources taken by the quadruple helix actors.

The first version of the paper was presented at the Semead 2020 Congress and it is coauthored by Aurora Carneiro Zen, Kadígia Faccin, Bruno Anicett Bittencourt, and Leonardo

Franke Gonçalves. A new version was submitted for the Technology Innovation Management Review (TIM Review) journal and is under appreciation.

After the mapping of the ecosystem and initial engagement of the actors, the **second paper**, entitled **"Orchestration of Actors and Resources in Innovation Ecosystems"**, discusses, through a theoretical approach, how actors and resources are orchestrated for the development of innovation ecosystems.

This paper's main argument is that the orchestration of actors and relational resources is paramount for innovation ecosystems to obtain sustainable competitive advantage (SCA). SCA is the outcome of relationships between a network of actors, whose interaction generates shared resources. As theoretical contributions, the paper highlights the importance of relational resources in innovation ecosystems, explores the role of the orchestration of actors and resources in creating SCA for ecosystems, and finally proposes a framework for researchers and practitioners.

The first draft of this paper was entitled "Relational Resources as Sources of Competitive Advantage in Entrepreneurial Ecosystems" and presented at the Infoclustering 2019 Congress. Next, an evolution of this paper regarding the context of innovation ecosystems was published in Portuguese under the title "Orquestração de Atores e Recursos em Ecossistemas de Inovação" and presented on the Enanpad 2020 Congress. This paper was the first step towards the construction of the subsequent empirical article.

The orchestration of actors and relational resources is again debated in the third paper, called **"Orchestration of Actors and Resources in Innovation Ecosystems: an empirical perspective"**, this time focusing on verifying in practice the theory built in the previous paper. This paper aims to understand, through a study case method, how actors and relational resources are orchestrated so that innovation ecosystems can achieve sustainable competitive advantage. For that purpose, the innovation ecosystem of Porto Alegre was chosen, given its recent efforts to be an internationally recognized IE.

This paper contributes to the literature mainly by highlighting the importance of relational resources in innovation ecosystems, exploring the role of the orchestration of actors and resources in creating sustainable competitive advantage for ecosystems, and validating a framework for researchers to analyze different innovation ecosystems and for practitioners to drive the ecosystems towards better development and the achievement of sustainable competitive advantage.

Co-authored by Aurora Carneiro Zen, Bruno Anicet Bittencourt, and Cristina Boari, this paper is going to to be submitted for the XLVI ANPAD Meeting – EnANPAD 2022, a congress that will be held online, between September 21 and 23, 2022.

Finally, building on the first three papers, the fourth paper, **"From Governance to Choreography: Coordination of Innovation Ecosystems"**, argues that innovation ecosystems have life cycle stages, and that for each stage, there is a coordination strategy – governance, orchestration, multiple orchestration, and choreography, which is more appropriate and that should help to provide better performance and achieve SCA.

This theoretical study develops and proposes a model for coordinating innovation ecosystems based on the theoretical backgrounds of IE coordination and IE life cycle. Therefore, it presents a framework to understand the coordination strategies better, considering the stages of an innovation ecosystem's life cycle, can support strategies to engage civil society in actions to develop innovation ecosystems, and guide the quadruple helix actors in the design of strategies for developing innovation ecosystems.

This dissertation closing paper, whose coauthors are Aurora Carneiro Zen and Bruno Anicet Bittencourt, was published in the Innovation and Management Review Journal (2021) under the title "From governance to choreography: coordination of innovation ecosystems".

In addition to this introductory chapter, this study has other five chapters, one for each paper, and a last one with the conclusion and final remarks. The appendices, when relevant, and the references are presented at the end of the respective papers, while the consolidated references are presented at the end of the thesis.

1.5 RELATIONSHIP BETWEEN PAPERS

The four papers that make up this dissertation are related as, together, they contribute to the understanding of how innovation ecosystems develop throughout their life cycle and which coordination mechanisms can be adopted.

These four papers share four main elements in common, which serve to construct the dissertation's guiding logic: territorial approach on innovation ecosystems (city level), quadruple helix, strategic resources and coordination mechanisms. As a background, the perspective of analyzing the papers comprises different stages through which the development of innovation ecosystems permeates: inception, launching, growth, and maturity. Table 1 summarizes these four papers.

Table 1: Synthesis of papers

	Paper 1	Paper 2	Paper 3	Paper 4
Title	Mapping, Analysing, and Designing Innovation Ecosystems in Cities: an Action Research Approach	Orchestration of Actors and Resources in Innovation Ecosystems	Orchestration of Actors and Resources in Innovation Ecosystems: an empirical perspective	From governance to choreography: coordination of Innovation Ecosystems
Objective	To propose and apply a method for map, analyze, and design IEs in cities through the engagement of quadruple helix actors and exploitation of strategic resources.	To propose a theoretical model on the role of orchestration of actors and resources in creating sustainable competitive advantage in IEs.	To understand how actors and relational resources are orchestrated so that IEs can achieve sustainable competitive advantage.	To analyze the coordination strategies of the actors throughout the life cycle of innovation ecosystems.
Theorethical Background	- IEs and the role of actors - Mapping, Analyzing, and Designing IEs in Cities	- Ecosystems and Networks - Actors and Resources of an IE - Orchestration of Resources in IE	- IEs in cities - Orchestration of Actors and Resources in IEs	- Life cycle of geographically bounded IEs - Coordination of IEs - Actors' coordination in the life cycle of IEs
Method	Action Research	Theoretical Essay	Case Study	Theoretical Essay
Results	Method for mapping, analyzing, and designing IEs in cities	Framework for analyzing the orchestration of actors and resources in IEs to obtain sustainable competitive advantage.	Framework of the orchestration of actors and resources in IEs to obtain sustainable competitive advantage validated.	Each stage of an IE's life cycle demands different coordination strategies – governance, orchestration, multiple orchestration or choreography.
Connection with the other papers	First step to understand how to nurture innovation ecosystems, identify its main actors and and mobilize the quadruple helix actors challenges to be overcome.	After an initial understanding on what are the main drivers for the development of an innovation ecosystem, there is a need to build a theoretical model for the mobilization of actors and leverage of resources.	This study provides empirical evidence for the framework of the orchestration of actors and resources in innovation ecosystems, analyzing a real case of ecosystem development innovation through this strategy.	Building on the results of the previous three papers, this study advances the theory by proposing different coordination strategies according to the life cycle stages of innovation ecosystems.
Status	- Early version published in Semead 2020 - Under revision in TIM Review	- Early versions published in Clustering 2019 and EnANPAD 2020	- Approved for presentation at the EnANPAD 2022 Congress	-Published in Innovation and Management Review (INMR)

Source: Author

Regarding the objectives, the first paper is concerned with proposing a method to map, analyze, and design innovation ecosystems in cities from the engagement of actors of the quadruple helix and the exploration of strategic resources. As a result of this first study, carried out through the action research method and with 135 participants involved, in addition to researchers, it was identified that the next step to mapping the innovation ecosystem would be the orchestration of actors and resources identified to engage the first and leverage the latter. Thus, the general objective of the second paper was to propose a theoretical model on the role of the orchestration of actors and resources in creating sustainable competitive advantage in innovation ecosystems.

In order to verify whether the theoretical model proposed in the second paper would have empirical validation, paper three aimed to provide empirical evidence for the framework of orchestration of actors and resources in innovation ecosystems, analyzing a real case of innovation ecosystem development a city level through this strategy.

Finally, based on the findings of the previous papers, the fourth and last paper discusses the possible coordination mechanisms and the most appropriate strategies for each stage of the life cycle of territorial innovation ecosystems, with a focus on ecosystems at the city level.

Therefore, the general and specific objectives of the dissertation are answered throughout the four papers that, when connected, provide an answer to the proposed research problem and provide theoretical and practical contributions. Table 2 below summarizes the objectives of the dissertation based on the four papers that comprise it.

Table 2: Papers and objectives

General objective: To analyze how actors and relational resources are coordinated in innovation ecosystems.				
Specific objectives	**Paper I**	**Paper II**	**Paper III**	**Paper IV**
a) Identify the main actors and resources of an innovation ecosystem;	X	X	X	
b) Propose a classification of actors and relational resources in innovation ecosystems;		X	X	
c) Understand the process of orchestrating actors and resources in innovation ecosystems;			X	
d) Develop a framework for actor's coordination in innovation ecosystems.				X

Source: Author

These specific objectives make it possible to achieve the theoretical and empirical contributions intended by the dissertation. Among the theoretical contributions are the advancement of the Resource-Based View theory and the approach of innovation ecosystems,

as well as the connection between these, the identification of relational resources of innovation ecosystems and the coordination strategies adopted for the development of these ecosystems at each stage of their life cycles. Empirically, the achievement of specific objectives makes it possible to identify key actors and strategic relational resources in innovation ecosystems, as well as providing support for their articulation and for the elaboration and implementation of public policies aimed at the development of innovation ecosystems at the territorial level, especially in cities.

Therefore, this doctoral dissertation is justified by presenting elements that help to understand the dynamics of evolution of innovation ecosystems with a territorial approach, by identifying, systematizing and presenting in a cohesive way the actors and resources of an innovation ecosystem, by identifying the strategies of coordination, and by proposing a model for orchestrating actors and resources, as well as developing a framework for coordinating innovation ecosystems, according to their life cycle stage.

2. PAPER I:

Mapping, Analyzing, and Designing Innovation Ecosystems in Cities: an Action Research Approach[1][2]

[1] An early version of this paper was presented at the Semead 2020 Congress.
Santos, D. A. G. dos; Zen, A. C.; Faccin, K. (2020). Mapping, Analyzing, and Designing Innovation Ecosystems in Cities: an Action Research Approach. In: XXIII Seminários em Administração - Semead 2020. São Paulo.
[2] A new version of this paper is currently under review at Technology Innovation (TIM Review). Authors: Santos, D. A. G. dos; Zen, A. C.; Faccin, K., Bittencourt, B. A., and Gonçalves, L. F. (2022).

ABSTRACT

Innovation ecosystems (IEs) in cities have been recognized as a critical force behind regional development. Hence, fostering IEs has been a priority for the development of cities and drives significant policy and program activities. In this paper, we argue that the first steps for the evolution of an IE are the engagement of the quadruple helix actors, i.e. academia, companies, government, and society, and the mapping of the IE, focusing on identifying the local challenges and making the IE able to generate and deliver value to all its stakeholders. For this investigation, we collected indicators and employed the Action Research (AR) approach, alongside Design Thinking, in five workshops in which participated 135 people form the quadruple helix in the IE of Porto Alegre, Brazil. The indicators provided guidance for relevant issues, and the workshops encouraged a multilateral collaboration between the actors. Thereby, we propose a five-step model based on AR and DT to improve collaboration and map IEs in cities, as cocreation processes can be fostered by applying this strategy.

Keywords: Innovation ecosystem, Ecosystem Mapping, Actors engagement, Action Research, Design Thinking

1. Introduction

Innovation ecosystems (IEs) in cities have been recognized as a critical force behind regional development (Audretsch and Belitski, 2017). There are several models presenting the main components and drivers of an ecosystem, and the number of publications concerning ecosystems has grown significantly. However, previous studies are mostly focused on entrepreneurial ecosystems, such as those of Isenberg (2010), Nicotra et al. (2018), and Spigel (2017). Moreover, there is neither any cohesive or systematic approach on how to nurture IEs in cities for their emergence, nor explicit directions on how to engage and enable collaboration among quadruple helix actors, i.e. academia, government, companies, and society.

We identified a gap in the literature regarding this process, especially in terms of the first steps of engaging the quadruple helix of actors and mapping the IE, focusing on identifying the local challenges and making the innovation ecosystem able to generate and deliver value to all its stakeholders. Hence, there is a growing need for a method to map innovation ecosystems and engage quadruple helix actors in co-creation processes, assisting these actors to align their interests, coordinate their actions, and exploit the relational resources.

In this study, we employ the action research (AR) approach alongside a design thinking (DT) orientation to propose and apply a method that enables engagement and collaboration between actors, thereby fostering the development of innovation ecosystems in cities - a territorial approach. AR can be especially useful in innovation contexts. It can provide novel insights and create new knowledge. Moreover, AR is different from the other approaches that have been widely used and exploited, providing a strong alternative method in this increasingly dynamic and complex field (Ollila and Ystrom, 2020). AR aims to produce practical knowledge in everyday life and to increase the wellbeing of human communities; it can also be a part of social and political movements for the development of a region, potentially having an impact on the lives of thousands or millions of people (Reason and Bradbury, 2008).

In the field of innovation, AR is an emerging scientific approach that allows for the generation of the knowledge of both academic and practical relevance. It emphasizes the simultaneous participation of researchers and practitioners in the context of a given phenomenon, generating an opportunity to create awareness of the topic and enabling the necessary changes to be made in its practice (Ollia and Ystrom, 2020). To date, there is a lack of studies employing AR in the investigation of innovation ecosystems. AR can generate novel insights into the literature, helping ecosystem managers to deliver its value proposition,

especially when jointly employed with other human-centered approaches (Brown, 2008), such as Design Thinking (DT).

DT can enable the engagement of quadruple helix actors in co-creation processes for the mapping of IEs. A DT-based approach allows a better fit between customer needs and market opportunities through innovative processes that will result in solutions that are desirable, feasible, and economically viable (Brown and Katz, 2009). Moreover, DT processes and tools enable the collaboration, engagement, and co-creation of value for actors with individual and sometimes conflicting interests, especially in complex environments such as cities.

The study area of our research is the innovation ecosystem of Porto Alegre, Brazil, given that it is an emergent ecosystem. Although Porto Alegre has the seventh-largest gross domestic product (GDP) in Brazil and approximately 1.4 million inhabitants, it is struggling to be more innovative and provide a better quality of life for its citizens. To overcome these challenges, Porto Alegre's three biggest universities and the city hall started a movement for the improvement of its innovation ecosystem through the joint efforts of academia, companies, government, and civil society.

In the subsequent sections, we present the theoretical background on innovation ecosystems, the role of the quadruple helix actors, and how they can engage and collaborate in co-creation processes. We also propose and explain a method we built through AR and DT, using the tools of personas and the Strength, Weaknesses, Opportunities, and Threats (SWOT) analysis, to improve co-creation processes to the map of innovation ecosystems. Then, we present how our method performed as well as the results of the workshops we conducted in Porto Alegre. We conclude with a discussion of the literature and the implications of the study. The main originality of this paper is the presentation of a method to improve collaboration and to map innovation ecosystems in cities based on five steps.

2. Literature Review

2.1. Innovation ecosystems and the role of actors

Innovation plays a major role in fostering economic development (Audretsch and Belitski, 2017; Schumpeter, 1985) and is one of the possible outcomes of the interaction of co-creative and interdependent actors arranged in apparently nonhierarchical networks (Suominen et al., 2018; Walrave et al., 2018) within an open and dynamic environment (Rabelo and Bernus, 2015). These environments are called innovation ecosystems (IEs), and they offer a systemic

approach to generate sustained competitive advantage. Thus, IEs are especially valuable in assisting a territory in achieving competitiveness.

The geographically bounded nature of a city innovation 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 (Presutti et al., 2013) and promotes the concentration of tangible (e.g., human and financial) and intangible resources (e.g., knowledge) (Jacobides et al., 2018; Thomas et al., 2018), which are paramount in innovation processes (Oliveira Jr. et al, 2019b).

Therefore, innovation ecosystems have non-linear and socially interactive dynamics (Acs et al., 2017; Stam, 2015). The complex, interdependent, symbiotic, and coevolutionary nature of these relationships among the different types of institutional entities and actors (Martins et al., 2019; Thomas et al., 2018) enables technological development and innovation (Jackson, 2011; Oliveira Jr. et al., 2019a). However, given their systemic and evolutionary character as well as the interference of conscious action by individuals and groups, innovation ecosystems are not expected to be stable. Hence, there is no ex-ante synchronization, and this generates complex issues of conflict that must be solved by the actors' reflection, discussions, and negotiations, to align the interests between them (Etzkowitz and Leydersdorff, 2000).

In such environments, actors are arranged in networks and interact in a complex way, competing but also cooperating (Shaw and Allen, 2016). They play complementary roles in co-creating value (Thomas et al., 2018) and can be classified according to the quadruple helix model (Arnkill, 2010; 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). Therefore, an innovation ecosystem can thrive only if there is the involvement and interplay of all four groups of actors in the process of innovation. The city innovation 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 diversity of people is one of the most important resources in this innovative process (Lehmann and Seitz, 2017), and their experience must be as meaningful and purposeful as possible (Pine and Gilmore, 1998).

In complex environments, such as IEs, key actors can influence and are affected by what happens within the system (Jones et al., 2002). Hence, 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).

2.2 Map, Analyze, and Design Innovation Ecosystems

To assess different elements of an ecosystem, a series of information on indicators and databases can be used. These are provided in previous studies, such as the work by Talmar et al. (2018), the famous ecosystem analysis model proposed by Isenberg (2010), scales to map the context of innovation presented in the OSLO manual (OECD, 2018), and also in certain handbooks, like the Handbook of Innovation Indicator and Measurement edited by Gault in 2013. However, like innovation, the study of indicators is a difficult topic.

Indicators are usually used to support public policymakers' decisions, particularly those who have recently dedicated themselves to the development of innovation ecosystems in cities and need to map their potential and design new policies to ensure scalability. Karlsen and Larrea (2016) emphasized that there is no unique prescription for territorial development. Territories vary greatly depending on location, and therefore 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). Based on this argument and the perception that there is no universal innovation policy available that fits all areas (Todling and Tripple, 2005), it is necessary to consider and learn about the differences between areas to achieve success in all territories (Ennals and Gustavsen, 1999). Thus, we believe that ecosystem mapping should follow this same approach. One of the roles of research is to engage in territorial development processes with policymakers and other regional actors so that a socially responsible common future can be created for the people who are working and living in a territory (Karlsen and Larrea, 2014). 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).

However, few studies have been widely recognized and used to map and propose improvements that would be socially recognized.

3. Method

We chose the approach of AR to propose and apply a method to map innovation ecosystems in cities through the improvement in collaboration and the engagement of 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 and engage people in co-creation processes to map the innovation ecosystem of Porto Alegre, Brazil.

In 2018, the three biggest universities in Porto Alegre, UFRGS, PUCRS, and Unisinos, the first being public and the other two privates, created the Alliance for Innovation with the support of the Porto Alegre City Hall. This alliance had the purpose of fostering the innovation ecosystem 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, that is, academia, civil society, companies, and government, in a joint effort to create a more 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 innovation ecosystem (Pacto Alegre, 2020). However, to achieve this objective, it was necessary to map, analyze, and design the innovation ecosystem.

The city of Porto Alegre was founded in 1772 and is the capital of Rio Grande do Sul, the southernmost state of Brazil. Its population is estimated at 1.48 million people and is known for its diversity and multiculturality (Prefeitura de Porto Alegre, 2019). Porto Alegre's GDP is worth R$ 73.5 billion, the seventh-largest in Brazil, corresponding to a GDP per capita of approximately R$ 49.5 thousand per year (IBGE, 2019). Porto Alegre was also the birthplace of Father Roberto Landell de Moura, one of the greatest Brazilian scientists and inventors who is recognized as a hero of the country (Brazil, 2012) for his pioneering role in the invention of the wireless radio and telephone, and to whom the city dedicated the title of the Patron of Science, Technology, and Innovation. Porto Alegre is also the birthplace of participatory budgeting, which is a practice recognized by the United Nations and the World Bank among the world's best in public management.

Furthermore, in 2015, Porto Alegre was recognized as one of the Brazilian capitals that best combines innovation, quality of life, interaction among actors, incentive policies, and economic development (Inovação, 2015). Its IE houses three internationally recognized science parks in addition to several business incubators and accelerators, which support entrepreneurs. Moreover, over the last few decades Porto Alegre has been subject to several problems that are putting its reputation at risk, keeping away visitors, and harming the well-being of its citizens. Until the 2000s, the city was a reference in terms of good quality of life in Brazil; however, in recent years, the degradation of urban conditions, historical buildings, and city streets is a symbol of the collapse expressed both subjectively, in the daily lives of its citizens, and also objectively, in development indexes. Therefore, we assume that innovation can drive the transformation and revitalization of the city. Moreover, the transition from a competitive to a cooperative scenario, the replacement of polarization by collaboration, and joint work among civil society, government, academia, and companies can make Porto Alegre more prosperous.

The AR approach 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. AR emerged from a broad range of fields and it considers the need for members from the object of inquiry itself to participate in the research (Brydon-Miller et al., 2003). AR is defined as a research strategy for change in real-time, where the three elements of research, action, and participation are connected and combined in the same process (Greenwood and Levin, 2007).

Hence, it is possible to understand AR as a set of practices and an orientation for inquiring that fosters the participation and active engagement of people, thereby stimulating them to use their creativity for contextual problem-solving. In this kind of research, people increase their ability to comprehend the systems of the world, collaborating to address key issues of their realities. Therefore, AR is a participatory, interactive, and emergent process based on relationships that bring together theory and practice, evolving alongside the capacity of individuals and collectivity (Brydon-Miller et al., 2003; Reason and Bradbury, 2008).

In this approach, we assume that people can have differing levels of involvement and different knowledge, skills, responsibilities, and social status that will provide a richer approach to pursuing a shared and desired purpose. In addition to the insiders, that is, people who are already living that reality and who will most directly feel the benefits from the process' outputs, it is also possible to have researchers or academia from the outside, who can contribute as facilitators according to their expertise in research, even if they do not share that reality (Brydon-Miller et al., 2003).

The execution of this AR was carried out through four classic 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 (Altrichter et al., 2002; Kemmis and McTaggart, 2005). 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 (Kemmis et al., 2014; McTaggart et al., 2017).

From the definition of the value proposition of the ecosystem, we started AR to map the innovation ecosystem activities. Based on our experience, we created a model to map other ecosystems. AR could enable the continued exploration of current issues related to innovation and innovation management (Ollia and Ystrom, 2020), as it has the potential to generate new knowledge that is both useful and rigorous. Hence, all the authors of this study participated actively as the designers of this methodology and as facilitators in every stage and in the entire research process. Moreover, all the participants described in each step were volunteers and contributed in representing the entities where they were working at that time or entities that they had been linked to in some way.

4. Building the mapping method

In this section, we present the steps we followed to build a methodology for mapping innovation ecosystems through engagement and collaboration between the actors of the quadruple helix. The execution of this process was based on the steps of the AR approach to assure the democratic participation of the experts and to provide an effective means of addressing the challenges associated with Porto Alegre's reality.

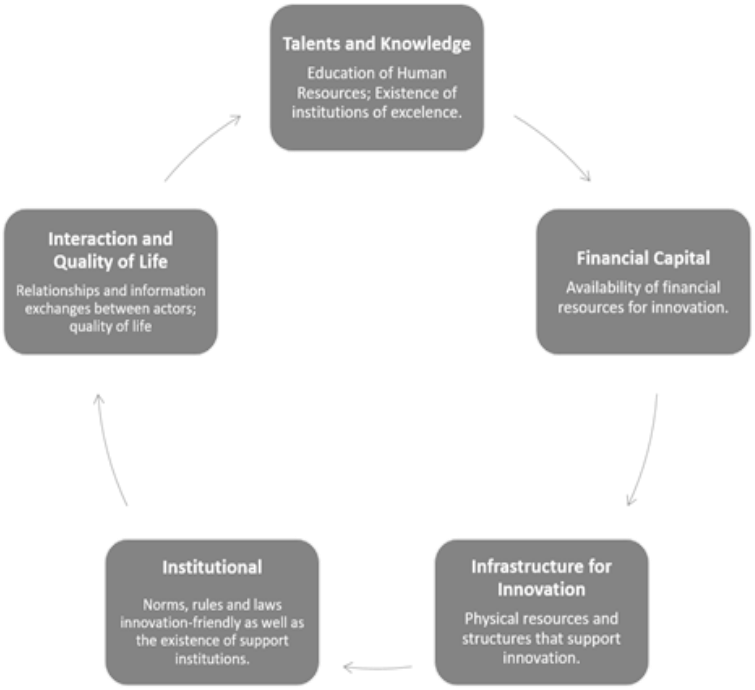
The movement for innovation in Porto Alegre began with the Alliance for Innovation and rapidly gave rise to the project Pact for Innovation, which then became Pacto Alegre. The Pacto Alegre started with a reunion among representatives from the three universities of the Alliance for Innovation, the city hall, and an international consultant, who had already worked in similar projects in Barcelona (Spain), Medellín (Colombia), and the state of Santa Catarina

in Brazil. This first meeting was attended by researchers, Ph.D. candidates, executives from science parks and incubators, technicians, secretaries, and directors from the city hall, as well as the major himself. The reunion set the schedule, structure, and macro-objectives for the project. One of the objectives of the project was to map the innovation ecosystem.

4.1 First Iterative Step

The first step in the AR process of developing a mapping method was to collect data to define the elements that generate value for the innovation ecosystem. We started searching literature that could serve as a guide in understanding the dynamics and mapping the innovation ecosystem of Porto Alegre. Then, we analyzed the dozens of papers and reports to propose a 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: talents and knowledge, financial capital, infrastructure for innovation, institutional, and interaction and quality of life. These dimensions comprises different resources innovation ecosystems can have and are shown in Figure 1.

Figure 1 – Dimensions and sequence of the workshops



Source: authors

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; Lambooy, 2006). Skilled individuals are a source of innovation owing to their knowledge and creativity (Urbancova, 2013). 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). Moreover, the diversification of economic activities in such cities can lead to many positive externalities and a greater propensity for innovation through the recombination of knowledge from different fields (Feldman and Audretsch, 1999).

On the other hand, financial capital is one of the most important attributes 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.

However, an IE is also highly dependent on physical resources; the structural dimension of an innovation ecosystem essentially 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). Institutions can encourage innovation as they 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; Roundy, 2018). Thus, a favorable institutional environment can encourage the collaboration, knowledge transfer, the emergence of new businesses, and the economic renewal of the region (Saxenian, 1994), providing a more attractive environment for people to work and live in.

Therefore, wellbeing and social relationships are among the most important resources in an IE. 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 (Bandera and Thomas, 2018; Spigel, 2017). Moreover, the cultural and contextual conditions enable people to live better and happier, and influence citizens' well-being and perceived quality of life.

In the process of defining these dimensions, there were sessions of feedback and discussion within the executive group. For example, the dimension of talents and knowledge started with the label "Intellectual Capital." After the group's feedback, it was renamed "Talent and Knowledge" to make it more accessible to people in general. At the end of this stage, we had a list of priority themes to map the levels of the development of the Porto Alegre ecosystem.

4.2 Second Iterative Step

Once the elements of analysis were defined, we initiated the pursuit for indicators. The search was carried out throughout 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 should come from safe and reliable sources and allow the comparison with other innovation ecosystems around the world. Following that, the authors had several planned meetings with the executive group of Pacto Alegre. In these meetings, there were several 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 indexes, 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. After choosing the labels and indicators, we selected an appropriate method through the collection of data regarding the chosen indicators.

4.3 Third Iterative Step

The third step was the collection of secondary data and indexes about the innovation ecosystem of Porto Alegre, which was collected from official agencies, supporting institutions, and national and international reports. After the data collection, 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 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.

In recent years, design has been recognized as an effective orientation to create novel and more meaningful experiences for users. Thus, DT is considered by many as a very broad tool to solve different types of 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. DT focuses on giving meaning to things instead of simply emphasizing the technical performance of something (Verganti and Dell'Era, 2008). Thus, DT could be an effective way of engaging people in co-creation processes.

DT can help in managing uncertainty and complexity, which are both generally associated with innovation. However, a shared definition of DT is still unclear even among scholars, and there are coexisting multiple and multifaceted concepts of this construct. Thus, managers and designers may have different views on DT as there is no current consensus on its meaning (Kleinsmann et al., 2017); this may act as a barrier to its adoption and usefulness (Verganti and Dell'Era, 2008). In this research, we define DT as a human-centered approach to innovation activities.

The decision to use DT is aligned with the contextual challenges and the intended objectives of this research (Kleinsmann et al., 2017). The use of innovative design puts more emphasis on the reason and purpose of people using something, i.e., the emotions (individual motivation) and symbolic (social motivation) reasons rather than just the features of a product. The new meanings can be a result of the evolution of the sociocultural context and the

emergence of new technologies (Verganti and Dell'Era, 2008). Therefore, design can be used as a strategy for fostering creativity and innovation and is used to address challenges and propose solutions (Kruger and Cross, 2006). The DT approach can be especially effective for solving problems in city innovation ecosystems, a process that should start with mapping.

4.4 Intermediate Step–Personas Creation

As researchers, we believed that the idea of using interactions between individuals to obtain more information that reflects the local reality would be interesting. In this sense, we decided to use a resource derived from strategic design: personas. Personas are fictitious, specific, and concrete representations of target audience who share common traits, needs, or behavior (Pruitt and Adlin, 2006). In our study, we designed different personas representing typical profiles of the citizens of Porto Alegre.

Thus, the intermediate iterative step of designing this method of mapping the ecosystem included the creation of personas capable of better reflecting the real problems experienced by the actors of the ecosystem. Hence, we created personas for each of the five elements of analysis identified in step 1. Approximately five personas were created for each element. As pointed out by Miaskiewicz and Kozar (2011), a persona should have a name, narrative, and picture to provide a more realistic archetype for the researcher to work with. In this study, each persona we designed had a name, a narrative, and an avatar as well as questions linked to the identification of existing strengths, weaknesses, opportunities, and threats in the ecosystem. After the presentation of the personas and the validation of the questions to encourage discussion among the pairs, the organization of the thematic workshops started.

4.5 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 "blade" of the helix: academia, government, companies, and society.

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, for example, a young graduate who intends to start a technology company and is analyzing whether he/she is staying in Brazil or going to live abroad. Based on the problems encountered by each participant, the experts were invited to discuss and then present the strengths, weaknesses, threats, and opportunities of Porto Alegre's innovation ecosystem. The use of personas, as we expected, confirmed to have several benefits aligning with those pointed out by Miaskiewicz and Kozar (2011), especially in terms of audience focus, agreement catalyst, engagement and unification, empathy creation, innovative thinking, team collaboration, problem scope definition, and articulate stakeholders' vision.

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 method for the following rounds. For example, in the first workshop, we proposed four personas, and the groups could choose two with whom they wanted to work with. However, only three of the four personas were selected and, therefore, the challenges related to one of the proposed personas were not discussed at any time. Hence, for the following workshops, we pre-defined the personas that each group would use, with the composition of the groups being random; that is, each workshop participant could choose their group. However, this was always based on preserving and balancing the configuration of groups, with at least one participant from each blade of the helix, such as academia, government, companies, and society, in each of the groups.

Another criticism was regarding the need for more diverse profiles representing the citizens of Porto Alegre. Thus, for the third round, six personas were prepared, and in the third and fourth rounds, eight personas were proposed instead of the initial four to more accurately represent the different profiles of Porto Alegre citizens. The diversity of personas supported our interest in having the most diverse profiles attending the workshops, given that social and cultural diversity can increase the innovativeness of an area (Lehmann and Seitz, 2017).

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. This happens due to the systemic nature, complexity, interdependence between actors and resources, and the overlapping of roles that occur on many occasions, given the dynamics of an innovation ecosystem.

In the five workshops we carried out, we observed that people who were invited to participate actively shared their perceptions and heard their pairs. Some of the people participated in more than one workshop, and as they continued participating in the activities, they felt increasingly engaged. As a spillover, they tended to suggest the invitation of other people from the outside, whose contribution would also be requested in the following workshops, people which may have never heard of the project or the workshops until then.

Therefore, each workshop had more collaboration, diversity, and a high-energy environment (Bathelt et al., 2004). It is possible that this high-energy environment resulted in an optimistic atmosphere, which was increasing with every subsequent step. 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). The results of the mapping of each of the dimensions of the Porto Alegre innovation ecosystem, as well as the main recommendations of the group of participants, are summarized in Table 3.

Table 3: Results of the 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 stricto sensu postgraduate programs - Number of patents requested per year.	- Resources and Infrastructure - Teaching Methodology - Policies for Talents - Educators' Motivation and Qualification - Collaboration	- Improve education strategies, focusing on E&I; - Disseminate good practices and methodologies for basic education; - Create a communication campaign for Porto Alegre; - Improve talent training, retention, and attraction; - 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 - Support - Policies for innovation and entrepreneurship - Market	- 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 Innovation	- Number of Science Parks; - Number of Business Incubators; - Number of Institutions to Support Entrepreneurship; - Number of Startups; - Number of Innovation Centers.	- Urban Mobility Telecommunications - Public-private partnerships - Support for innovation and entrepreneurship.	- Improve public transportation; - Improve data and telecommunications infrastructure; - Inform the population about public transportation means schedule; - Develop long-term planning for innovation and entrepreneurship; - Improve the integration between public and private entities.
Institutional	- 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 innovation; - Tax Incentives for Innovation and Entrepreneurship; - 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 to strengthen innovation and entrepreneurship - Promote a 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 environments; - Foster social businesses, - Identify and enhance local talent; - Attract large infrastructure projects.

Source: authors

The design applied to innovation often results in new and meaningful experiences for society (Verganti and Dell'Era, 2014). Nevertheless, the method of encouraging the collaboration between people from different backgrounds, many of whom would have never met each other before, results in the persistence of certain problems. The first problem is about the inclusion of people from the periphery as the participants in the workshops were almost all invited via a snowball-like technique, as people were inviting others who they deemed as potential contributors. In this way, people outside some social circles may have been accidentally excluded from the discussions. As the workshops were progressing, more people from other social contexts started participating; however, we must assume that it was not possible to achieve the full representation of the entire spectrum of Porto Alegre's society.

As the interplay of actors took place, the collaboration among them increased, suggesting that there was a process of learning and trust-building. Trust is a strategic resource (Jarillo, 1988; Uzzi, 1996) especially in innovation ecosystems, where actors are not managed hierarchically (Suominen et al., 2018; Thomas and Autio, 2020) and tend to behave opportunistically (Ghio et al., 2019), such as in the example of Pacto Alegre.

Therefore, encouraging multilateral collaboration among actors is crucial in achieving the level of engagement necessary to produce innovation (Provan et al., 2007). Both the AR and the DT oriented activities helped the researchers to conduct the co-creation processes considering the intended impact on society, while stimulating the participation of actors in taking a systematic and not just an individualistic view of their roles. Hence, the personas and SWOT analysis tools enabled actors to engage in the diagnosis of the ecosystem challenges, thereby leveraging the joint efforts for problem solving (Jones et al., 2002).

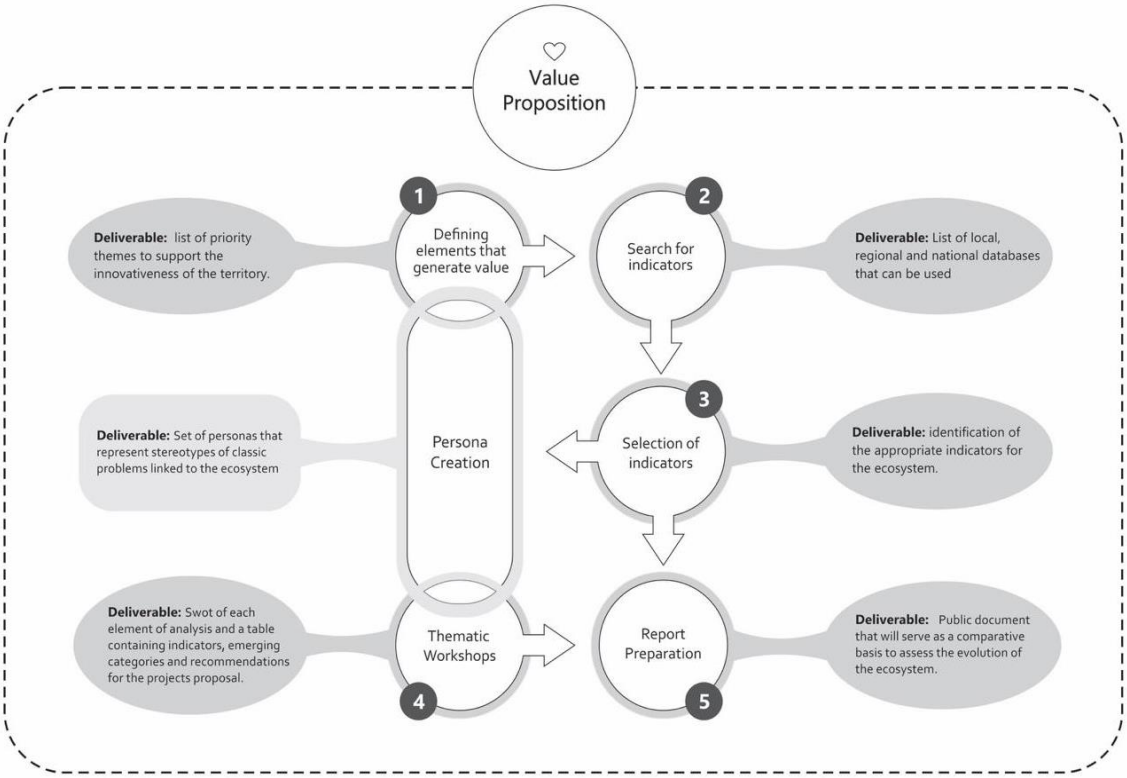
4.6 Sixth Iterative Step

Based on the collected data, we started preparing the report. After the presentation of the steps followed for the mapping, a comprehensive document was delivered to the community on the mapping of the ecosystem of the city of Porto Alegre; this document can elucidate the complexity and the relationship between the main challenges to design the transformation of the city. Based on the data and information collected from the reports and participants in the five workshops, the main challenges identified for designing the innovation 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 IEs through the engagement of quadruple helix actors, i.e., academia, government, companies, and civil society. This approach proved to be useful as the context of our research shares a similar configuration to that researched by Ollila and Ystrom (2020), in the sense that Pacto Alegre is also a collaborative initiative at the forefront of innovation, characterized by high levels of uncertainty and ambiguity. Moreover, Pacto Alegre does not have control over the resources of its participating members and depends on the alignment and collaboration among the actors (Etzkowitz and Leydersdorff, 2000), as well as on their engagement in co-creation processes. During the entire process, the interaction among the actors proved itself valuable, as it provided rich discussions and an aggregation of different perspectives, resulting in knowledge spillovers (Presutti et al., 2013) and useful insights.

The activities created to map the innovation ecosystem, in the core of the Pacto Alegre project, not only provide us with the opportunity to map and improve collaboration in the IE, but also to create a method for other cities that have the desire to develop their own innovation ecosystems. We understand that AR proved to be an especially useful method for making changes and simultaneously generating theory from practice. The method for mapping and proposing improvements to IEs based on the engagement of actors from the quadruple helix is composed of five iterative steps and is presented in a simplified way in Figure 2.

Figure 2 – Five-step model to map innovation ecosystems in cities



Source: authors

5. Conclusion

In this paper, we proposed and applied a method to map innovation ecosystems in cities from the engagement and collaboration between actors. Mapping through the engagement of actors is a starting point for a more developed ecosystem. In this study, it was possible to notice how co-creation processes can be fostered by applying the AR approach alongside DT strategies for the mapping of the innovation ecosystem. 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 built a method to support the translation of tacit knowledge in scientific knowledge through the interventions of the researchers. This research also presented the opportunity to investigate the creation of a collaborative innovation setting (Ollila and Ystrom, 2020). Hence, we demonstrated empirically how this method can create new knowledge, benefitting the increasingly dynamic and complex field of innovation, while providing novel insights that are different from those of other more common and typical approaches normally applied in this context.

DT can be a valuable source of innovation in different contexts and levels, from firms to cities and regions. In this research, we provided some insights into the application of DT for mapping and developing innovation ecosystems through the engagement of stakeholders. We showed that an approach centered on people and one that generates value for multiple stakeholders can engage and deliberatively improve the success of diagnosing the challenges that are identified in cities or communities of individuals, while proposing solutions. In addition, the use of AR and DT was shown to be a robust combination for empowering and considering people, thereby joining both university and public actors for the generation of new knowledge and for a novel approach that links research more directly to results that are perceived by society.

Therefore, this study was also an opportunity to contribute to the emerging body of literature that employs the AR method as a new approach that generates knowledge while revisiting existing knowledge from an analysis perspective that is different from those traditionally employed in that field, adding an intervention dimension to the studied phenomenon. This research also highlighted the link between innovation ecosystems and DT

literature, explicitly showing that DT can also improve innovation processes and be applied at an inter-organizational and meso level of analysis, especially in this specific ecosystem context. Moreover, this study helps to connect the literature on innovation context with DT practices (Kleinsmann et al., 2017).

For practitioners, policymakers, and other stakeholders interested in fostering innovation ecosystems, this study also offers a detailed method and provides guidelines for using tools such as personas and SWOT analysis to conduct a deliberate development process through innovation and collaboration. The workshops can serve as networking events in which people can meet each other and feel comfortable exchanging knowledge in an informal environment. 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.

The main limitation of this research lies in its application to one case, a pilot case. Thus, further research should apply this method for mapping ecosystems in other contexts. In addition, other tools of DT or other approaches should be tested, such as agile and gamification. Moreover, when the data was collected during the workshops, the participants had different levels of knowledge about their organizations as well as the different roles of people in different contexts. Consequently, problems can arise from the people of the same background in terms of issues relating to power discrepancy, as already pointed out by Townsend (2014). 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.

Acknowledgements

We would like to thank the executive group of Pacto Alegre, which gave us support for the research.

Funding

This study was financed in part by the Fundação de Amparo à pesquisa do Estado do Rio Grande do Sul, and by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES) – Finance Code 001.

References

Acs, Z. J., Szerb, L., & Autio, E. (2015). National systems of entrepreneurship. In Acs, Z. J., Szerb, L., & Autio, E. *Global Entrepreneurship and Development Index 2014* (pp. 13-26). Cham: Springer International Publishing. Retrieved from: https://link.springer.com/book/10.1007%2F978-3-319-14932-5. https://doi.org/10.1007/978-3-319-14932-5

Altrichter, H., Kemmis, S., McTaggart, R., Zuber-Skerritt, O. (2002). The concept of action research. The learning organization.

Arnkill, R., Järvensivu, A., Koski, P., Piirainen, T. (2010). Exploring Quadruple Helix Outlining User-Orientated Innovation Models. INTERREG IVC Programme.

Asheim, B. (2007). Differentiated knowledge bases and varieties of regional innovation systems. *Innovation*, *20*(3), 223-241.

Audretsch, D. B., & Belitski, M. (2017). Entrepreneurial ecosystems in cities: establishing the framework conditions. *The Journal of Technology Transfer*, *42*(5), 1030-1051. Retrieved from: https://link.springer.com/article/10.1007%2Fs10961-016-9473-8 https://doi.org/10.1007/s10961-016-9473-8

Bandera, C., Thomas, E. (2018). The role of innovation ecosystems and social capital in startup survival. IEEE Transactions on Engineering Management 66(4), 542-551.

Bathelt, H., Malmberg, A., Maskell, P. (2004). Clusters and knowledge: Local buzz, global pipelines, and the process of knowledge creation. Progress in human geography 28(1), 31-56.

Brown, T (2008). Design thinking. *Harvard Business Review* 86(6), 84.

Brown, T., Katz, B. (2009). *Change by Design*: How Design Thinking Transforms Organizations and Inspires Innovation. Harper Collins, New York.

Brydon-Miller, M., Greenwood, D., Maguire, P. (2003). Why action research? Action Research 1(1), 10.

Carayannis, E. G., & Campbell, D. F. (2009). 'Mode 3' and 'Quadruple Helix': toward a 21st century fractal innovation ecosystem. International Journal of Technology Management, Vol. 46 No. 3-4, pp. 201-234.

Carayannis, E. G., Grigoroudis, E., Campbell, D. F. J., Meissner, D. & Stamati, D. (2018), The ecosystem as helix: an exploratory theory-building study of regional co-opetitive entrepreneurial ecosystems as Quadruple/Quintuple Helix Innovation Models. *R&D Management*, 48, 148-162. Retrieved from: https://onlinelibrary.wiley.com/doi/abs/10.1111/radm.12300 https://doi.org/10.1111/radm.12300

Cavallini, S., Soldi, R., Friedl, J., & Volpe, M. (2016). Using the quadruple helix approach to accelerate the transfer of research and innovation results to regional growth. *Consortium Progress Consulting Srl & Fondazione FoRmit*. Retrieved from: https://op.europa.eu/en/publication-detail/-/publication/6e54c161-36a9-11e6-a825-01aa75ed71a1

Edquist, C. (2001). The Systems of Innovation Approach and Innovation Policy: An account of the state of the art. In DRUID conference, Aalborg.

Ennals, J. R., Gustavsen, B. (1999). Work Organization and Europe as a Development Coalition (Vol. 7). John Benjamins Publishing, Amsterdam, Netherlands.

Etzkowitz, H., & Leydesdorff, L. (2000). The dynamics of innovation: from National Systems and "Mode 2" to a Triple Helix of university–industry–government relations. *Research Policy*, *29*(2), 109-123. Retrieved from: https://www.sciencedirect.com/science/article/abs/pii/S0048733399000554?via%3Dihub https://doi.org/10.1016/S0048-7333(99)00055-4

Feldman, M.P., Audretsch, D.B. (1999). Innovation in cities: Science-based diversity, specialization and localized competition. European economic review 43(2), 409-429.

Florida, R. (2002). The Rise of the Creative Class (Vol. 9). Basic Books, New York.

Gault, F. (Ed.) (2013). Handbook of innovation indicators and measurement. Edward Elgar Publishing, United Kingdom.

Ghio, N., Guerini, M. & Rossi-Lamastra, C. (2019) The creation of high-tech ventures in entrepreneurial ecosystems: exploring the interactions among university knowledge, cooperative banks, and individual attitudes. *Small Business Economics* 52, 523–543. Retrieved from: https://link.springer.com/article/10.1007/s11187-017-9958-3 https://doi.org/10.1007/s11187-017-9958-3

Greenwood, D.J., Levin, M. (2007). An epistemological foundation for action research. Introduction to action research, 55-76.

Inovação (2015). As dez cidades mais inovadoras do país.

Isenberg, D.J. (2010). How to start an entrepreneurial revolution. *Harvard Business Review*, 88(6), 40-50.

Isenberg, D.J. (2011). The entrepreneurship ecosystem strategy as a new paradigm for economic policy: principles for cultivating entrepreneurship. Babson Entrepreneurship Ecosystem Project, Babson College, Babson Park: MA.

Jackson, D. J. (2011). What is an innovation ecosystem. *National Science Foundation*, *1*(2), 1-13.

Jacobides, M. G., Cennamo, C., & Gawer, A. (2018). Towards a theory of ecosystems. *Strategic Management Journal*, *39*(8), 2255-2276. Retrieved from: https://onlinelibrary.wiley.com/doi/full/10.1002/smj.2904. https://doi.org/10.1002/smj.2904

Jarillo, J. C. (1988). On strategic networks. *Strategic Management Journal*, *9*(1), 31-41. Retrieved from: https://onlinelibrary.wiley.com/doi/abs/10.1002/smj.4250090104 https://doi.org/10.1002/smj.4250090104

Jones, T. M., Wicks, A.C., Freeman, R.E. (2002). Stakeholder Theory: The State of Art.

Karlsen, J., Larrea, M. (2016). Territorial Development and Action Research: Innovation Through Dialogue. Routledge, United Kingdom.

Kemmis, S., Mctaggart, R. (2007). Participatory Action Research. In Denzin, N. K.; Lincoln, Y. Handbook of qualitative research (3 Ed). Sage Publications, Inc., London.

Kleinsmann, M., Valkenburg, R., Sluijs, J. (2017). Capturing the value of design thinking in different innovation practices. International Journal of Design 11(2), 25-40.

Kruger, C., Cross, N. (2006). Solution driven versus problem driven design: strategies and outcomes. *Design Studies* 27(5), 527–548.

Lambooy, J.G. (2006). Knowledge dissemination and innovation in urban regions: An evolutionary perspective. In Jarillo, F. J. Knowledge Cities (pp. 239-248). Routledge.

Lehmann, E.E., Seitz, N. (2017). Freedom and innovation: A country and state level analysis. The Journal of Technological Transfer 42**,** 1009–1029.

Martins, B.V., Faccin, K., Motta, G.D.S., Bernardes, R., Balestrin, A. (2019). Evolução e tendências da agenda de pesquisa internacional em inovação. *Revista de Administração de Empresas*, 59(4), 293-307.

McTaggart, R., Nixon, R., Kemmis, S. (2017). Critical Participatory Action Research. In The Palgrave international handbook of action research. ed. L. Rowell, C. D. Bruce, J. M. Shosh and M. M. Riel. Palgrave Macmillan, New York.

Miaskiewicz, T., Kozar, K.A. (2011). Personas and user-centered design: How can personas benefit product design processes?. Design Studies 32(5), 417-430.

Muñoz, P., Kibler, E., Mandakovic, V., Amorós, J. E. (2020). Local entrepreneurial ecosystems as configural narratives: A new way of seeing and evaluating antecedents and outcomes. *Research Policy* 104065. doi:10.1016/j.respol.2020.104065

Nicotra, M., Romano, M., Del Giudice, M., & Schillaci, C. E. (2018). The causal relation between entrepreneurial ecosystem and productive entrepreneurship: A measurement framework. *The Journal of Technology Transfer*, *43*(3), 640-673. Retrieved from: https://link.springer.com/article/10.1007%2Fs10961-017-9628-2.

OECD Publishing (2018). Oslo Manual 2018: Guidelines for collecting, reporting and using data on innovation. Organisation for Economic Co-operation and Development OECD.

Oliveira Jr., Moacir de Miranda, Cahen, Fernanda Ribeiro; Borini, Felipe Mendes (2019). Introduction. In: Startups and Innovation Ecosystems in Emerging Markets. Palgrave Macmillan, Cham, 2019a.

Ollila, S., Yström, A. (2020). Action research for innovation management: three benefits, three challenges, and three spaces. RandD Management. doi:10.1111/radm.12407

Pine, B.J., Gilmore, J.H. (1998). Welcome to the experience economy. *Harvard Business Review*, 76, 97-105.

Pisano, G.P., Verganti, R., 2008. Which kind of collaboration is right for you. *Harvard Business Review* 86(12), 78-86.

Presutti, M., Boari, C., & Majocchi, A. (2013). Inter-organizational geographical proximity and local startups' knowledge acquisition: a contingency approach. *Entrepreneurship & Regional Development*, Vol. 25, No. 5-6, pp. 446-467.

Pruitt, J., Adlin, T. (2006). The persona lifecycle: Keeping people in mind throughout product design. Morgan Kaufmann, San Francisco.

Rabelo, R. J., & Bernus, P. (2015). A holistic model of building innovation ecosystems. *IFAC-PapersOnLine*, *48*(3), 2250-2257. Retrieved from: https://www.sciencedirect.com/science/article/pii/S240589631500662X?via%3Dihub. https://doi.org/10.1016/j.ifacol.2015.06.423

Reason, P., Bradbury, H. (Eds.) (2001). Handbook of Action Research: Participative Inquiry and Practice. Sage.

Roundy, Philip T. (2018). Rust belt or revitalization: competing narratives in entrepreneurial ecosystems. Management Research Review, https://doi.org/10.1108/MRR-01-2018-0019

Saxenian, A., 1994. *Regional advantage*: Culture and competition in Silicon Valley and Route, 128.

Shaw, D. R., & Allen, T. (2018). Studying innovation ecosystems using ecology theory. *Technological Forecasting and Social Change*, *136*, 88-102. Retrieved from: https://www.sciencedirect.com/science/article/abs/pii/S0040162516307880?via%3Dihub. https://doi.org/10.1016/j.techfore.2016.11.030

Sotarauta, M. Pulkkinen, R. (2011). Institutional entrepreneurship for knowledge regions: In search of a fresh set of questions for regional innovation studies. Environment and Planning C: Government and Policy 29(1), 96-112.

Spigel, B. (2017). The relational organization of entrepreneurial ecosystems. *Entrepreneurship Theory and Practice*, *41*(1), 49-72. Retrieved from: https://journals.sagepub.com/doi/10.1111/etap.12167. https://doi.org/10.1111/etap.12167

Stam, E. (2015). Entrepreneurial ecosystems and regional policy: a sympathetic critique. *European Planning Studies*, *23*(9), 1759-1769. Retrieved from: https://www.tandfonline.com/doi/full/10.1080/09654313.2015.1061484. https://doi.org/10.1080/09654313.2015.1061484

Suominen, A., Seppänen, M., Dedehayir, O. (2019). A bibliometric review on innovation systems and ecosystems: A research agenda. European Journal of Innovation Management 22(2), 335-360. Retrieved from: https://www.emerald.com/insight/content/doi/10.1108/EJIM-12-2017-0188/full/html. https://doi.org/10.1108/EJIM-12-2017-0188

Talmar, M., Walrave, B., Podoynitsyna, K.S., Holmström, J., Romme, A.G.L. (2018). Mapping, analyzing and designing innovation ecosystems: The Ecosystem Pie Model. Long Range Planning 53(4), 101850.

Thomas, L. D., & Autio, E. (2020). Innovation Ecosystems in Management: An Organizing Typology. In *Oxford Research Encyclopedia of Business and Management*. Retrieved from: https://oxfordre.com/business/view/10.1093/acrefore/9780190224851.001.0001/acrefore-9780190224851-e-203. https://doi.org/10.1093/acrefore/9780190224851.013.203

Thomas, L.D., Sharapov, D., Autio, E. (2018). Linking entrepreneurial and innovation ecosystems: The case of AppCampus. In Entrepreneurial ecosystems and the diffusion of startups. Edward Elgar Publishing, United Kingdom.

Tödtling, F., & Trippl, M. (2005). One size fits all?: Towards a differentiated regional innovation policy approach. *Research policy*, *34*(8), 1203-1219.

Townsend, A. (2014). Collaborative action research. In The SAGE encyclopedia of action research. ed. D. Coghlan and M. Brydon-Miller. Sage.

Urbancova, H. (2013). Competitive advantage achievement through innovation and knowledge. Journal of competitiveness 5(1), 82-96.

Uzzi, B. (1996). The sources and consequences of embeddedness for the economic performance of organizations: The network effect. *American Sociological Review*, 674-698. Retrieved from: https://www.jstor.org/stable/2096399?origin=crossref&seq=1#metadata_info_tab_contents. https://doi.org/10.2307/2096399

Verganti, R., Dell'Era, C. (2014). Design-driven innovation: Meaning as a source of innovation. In: The Oxford Handbook of Innovation Management. ed. M. Dodgson, D. Gann and F. Phillips. Oxford University Press, Oxford.

Walrave, B., Talmar, M., Podoynitsyna, K. S., Romme, A. G. L., & Verbong, G. P. (2018). A multi-level perspective on innovation ecosystems for path-breaking innovation. *Technological Forecasting and Social Change*, *136*, 103-113. Retrieved from:

https://www.sciencedirect.com/science/article/abs/pii/S0040162517304997?via%3Dihub. https://doi.org/10.1016/j.techfore.2017.04.011

WEF - World Economic Forum, 2013. Entrepreneurial ecosystems around the globe and early-stage company growth dynamics: the entrepreneur's perspective. Avaiable at http://www3.weforum.org/docs/WEF_EntrepreneurialEcosystems_Report_2013.pdf

3. PAPER II:

Orchestration of Actors and Resources for the Development of Innovation Ecosystems[3]

[3] Early versions of this paper were presented at the Clustering 2019 and EnANPAD 2020 congresses.
Santos, D. A. G. dos; Zen, A. C. (2019). Relational Resources as Sources of Competitive Advantage in Entrepreneurial Ecosystems. In: Fourth International Conference on Clusters and Industrial Districts - Clustering 2019. València.
Santos, D. A. G. dos; Zen, A. C. (2020). Orquestração de Atores e Recursos em Ecossistemas de Inovação. In: XLIV Encontro da Anpad - EnANPAD 2020.

ABSTRACT

Objective: This paper aims to understand how actors and resources are orchestrated for the development of innovation ecosystems. **Method:** This work is characterized as a theoretical essay, and addresses the relationship between the Resource Based View (RBV), in its relational perspective, Network and Resource Orchestration, and Innovation Ecosystems. Its main argument is that the orchestration of actors and relational resources is fundamental for innovation ecosystems to obtain sustainable competitive advantage. **Results:** Sustainable competitive advantage result from relationships between a network of actors, through benefits generated jointly. These partnerships are essential in innovation ecosystems, composed of networks of interacting and interdependent actors formed by actors from the Academy, Companies, Government and Society. In a context of uncertainty and diffuse interests, the orchestration of actors and relational resources can generate sustainable competitive advantage for the ecosystem. **Conclusion:** This paper contributes to the literature mainly by highlighting the importance of relational resources in innovation ecosystems, exploring the role of the orchestration of actors and resources in creating sustainable competitive advantage for ecosystems, and proposing a framework for researchers and practitioners.

Keywords: Innovation Ecosystem; Resource-Based View; Relational View; Network Orchestration; Resource Orchestration.

1. Introduction

The most successful economies today are no longer those based on goods, but rather on ideas and knowledge (Florida, 2012; Acs, Zerb and Autio, 2015). These are inputs for innovation, fundamental to the generation of employment, income and social well-being and, therefore, the driving force of development (Schumpeter, 1982). However, for innovation to be feasible in a territory, it is necessary to promote innovation ecosystems (IE), which bring together the actors and resources necessary for the innovative process. Thus, the promotion of IE presents itself as one of the most important strategies for local and regional socioeconomic development.

Innovation ecosystems can be defined as the result of interaction between multiple networks of actors, covering both resources and the dynamics of cooperation, competition and the relationship between them. In locoregional contexts, IE are open, dynamic and geographically bounded environments (Rabelo and Bernus, 2015), permeated by cyclical flows of tangible resources - such as human and financial - and intangible resources - such as information -, whose actors, structured in networks, interact in a complex way, competing, but also cooperating and sharing resources with each other to co-create value and innovate (Shaw and Allen, 2016). Therefore, it is possible to understand these ecosystems as a set of actors, resources and processes that, together, promote innovation in a given place.

Resource-Based View (RBV) can contribute to the explanation of this phenomenon. RBV considers the firm as a set of complementary resources (Wernerfelt, 1984), which allow it to obtain superior performance (Barney and Clark, 2007) and competitive advantage (Barney, 1991; Zen and Fracasso, 2011). This theory has become one of the most prominent in the field of strategy, being used to explain phenomena even beyond the borders of the firm, such as the benefits arising from cooperation and involvement in networks, focus of analysis from the relational perspective (Dyer and Singh, 1998). In Relational View, actors form partnerships to create and capture value from complementary resources, enjoying network benefits (Dyer, Singh and Hesterly, 2018).

However, the simple existence of resources is not a guarantee of success. Hence, the orchestration of the relational resources of the ecosystem is fundamental for its leverage and realization of its potential (Sirmon, Hitt, Ireland and Gilbert, 2011). Therefore, the strategies employed to orchestrate complementarities and resource flow in an innovation ecosystem can increase its performance (Walrave, Talmar, Podoynitsyna, Romme and Verdong, 2018),

whereas if coordination within the ecosystem is inadequate, innovations will fail (Jacobides, Cennamo and Gawer, 2018). The orchestration of actors and resources in innovation ecosystems acknowledge that network structures and external relations are essential characteristics for knowledge transfer (Boari and Lipparini, 1999) and, consequently, for innovation (Fernandes, Oliveira, Sbragia and Borini, 2017). Thus, relational resources can generate sustainable competitive advantage in an innovation ecosystem as long as the strategic resources are identified and an effective orchestration process to mobilize and exploit these resources through a collective strategy is shared by its actors.

This theoretical essay, therefore, aims to analyze the role of the orchestration of actors and relational resources in the creation of sustainable competitive advantage in the context of innovation ecosystems. This study can contribute to the management literature, especially in the innovation and strategy streams, as the association between RBV and orchestration in innovation ecosystems represents a new combination, a new level of analysis and a new field of application for RBV, with significant potential for advances to the strategy literature. Faced with a context with diffuse interests, such as innovation ecosystems, where actors compete and cooperate each other concomitantly, the orchestration of strategic resources can influence their effective mobilization and exploitation through a collective strategy, resulting in competitive advantage for the actors, as well as superior performance for the ecosystem.

2. Ecosystems and Networks

Ecosystem research belongs to a broad and heterogeneous body of literature in the field of strategy, being highly influenced by other approaches, especially that of networks. However, ecosystems have idiosyncrasies that distinguish them from traditional types of networks. Thus, although influenced by the theoretical bases of networks, the construct “ecosystem” exhibits distinct characteristics that separate it from the types presented in the literature (Autio and Thomas, 2014; Shipilov and Gawer, 2020). In addition to the biological origin of the term, ecosystems differ from the types “value chain” and “supply chain” because they have a nonlinear aspect, including vertical and horizontal relationships between the actors, and because they explicitly consider both the production and use side. The ecosystem construct also differs from constructs related to value creation, such as “value networks” and “value constellations”, due to its focus on the evolution of networks of interconnected actors towards new states, rather

than emphasizing an existing and immutable network configuration (Autio and Thomas, 2014).

The explicit inclusion of participants on the use side also makes ecosystems distinct from other concepts such as clusters, innovation networks and industrial networks, for example, which tend to focus on the production side. User networks, on the other hand, focus exclusively on the end use of industrial value chains. In addition, ecosystems are distinguished by covering a wide variety of stakeholders, being perhaps the broadest of the different constructs influenced by the network approach in the strategic perspective (Autio and Thomas, 2014), and by considering the capacity of a territory to create a system of actors and infrastructures, in addition to the mere construction of a network structure between companies (Nicotra, Romano, Del Giudice, and Schillaci, 2018). Finally, the differences in relation to the other typologies also refer to the fact that they eventually do not reveal, at least explicitly, the purpose of relations (Adner, 2017) which, in the case of innovation ecosystems is the innovation itself (Reynolds and Uygun, 2018).

Thus, ecosystems comprise a specific and peculiar logic of networks, encompassing a diverse community of actors with multilateral and multisectoral ties, crossing the borders of a single industry and emphasizing the increase of interdependence, as well as the symbiotic potential between the actors (Adner, 2017). Accordingly, the ecosystem can include participants from outside the traditional supplier and distributor value chain, such as outsourcing companies, financial institutions, technology providers, competitors, customers, and regulatory and coordination bodies (Autio and Thomas, 2014).

Therefore, an innovation ecosystem consists of a set of multiple actors connected by a set of multilateral ties (Borgatti and Foster, 2003; Provan, Fish, and Sydow, 2007) and interconnected with each other through a wide range of social and economic relations (Uzzi, 1996; Gulati, 1998). In this perspective of locoregional analysis, each innovation ecosystem presents its own idiosyncrasies, conditioned to contextual conditions and corresponds to a unique configuration in which actors collectively create, deliver and appropriate value through innovation (Walrave *et al.*, 2018). For this reason, in order for such ecosystems to achieve a sustainable competitive advantage, they must identify which are their main actors and strategic resources.

3. Actors and Resources of an Innovation Ecosystem

Regions can be defined as ecosystems of actors with conflicting or converging technical, social, economic and political interests, as well as goals, priorities, expectations and behaviors. Thus, innovation ecosystems are hybrids of different networks and systems with fractal, multilevel, multimodal, multi-module and multilateral configurations, with tangible and intangible dynamic assets aimed at promoting innovation in a territory (Carayannis, Grigoroudis, Campbell, Meissner and Stamati, 2018). Depending on the role played in the ecosystem, the actors can be distributed among four groups: academy, companies, government and society. The model that covers this classification of entities, as well as the interaction between them, whose purpose is to generate innovation, is called "quadruple helix".

Helix approaches emphasize the importance of interaction between the academy, companies and government, entities that form the triple helix, in addition to civil society (fourth "blade" of the helix), so that processes of creation, diffusion and application of new knowledge occur, which can result in new technologies and, ultimately, through the capture and delivery of economic and social value, regional development (Cavallini, Soldi, Friedl and Volpe, 2016). While the Triple Helix model emphasizes the interrelationships and transformations in the role of the state, corporations and academy in innovation, i.e., the actors on the production side (Etzkowitz and Leydersdorff, 1995), the quadruple helix model brings to light the importance of the civil society, representing the user side (Carayannis *et al.*, 2018).

In the triple helix model (Etzkowitz and Leydersdorff, 1995), the academy, business and government interact to generate innovation in a territory. Thus, this model emphasizes the importance of having an environment in which there are constant trilateral interactions between public policies, research groups and companies, with the aim of achieving knowledge-based economic development (Etzkowitz and Leydersdorff, 2000; Carayannis *et al.*, 2018). The triple helix model tends to be even more effective in territories whose economy is based on knowledge, with companies oriented to innovation and the presence of hybrid institutions, and can also provide an analytical and operational tool for proposing public policies adapted to the peculiarities of local contexts (Cavallini *et al.*, 2016).

In the triple helix, the dynamics of university-industry-government relations are generated endogenously, not linear, and in constant transformation; with a certain frequency, the helices can overlap each other in relation to the roles they play. Similarly, networks are not expected to be stable, given their evolutionary character and the interference of the conscious action of individuals and groups. Moreover, there is no ex ante synchronization, generating puzzles that must be solved by the actors through processes of reflection, discussions and

negotiations, so as to align interests between them (Etzkowitz and Leydersdorff, 2000).

According to the triple helix, the academy can contribute to the innovation ecosystem through a unique configuration of resources, which blends memory and new ideas, continuity and change, especially through the passage of student generations (Etzkowitz and Leydersdorff, 2000). In turn, companies serve the production of innovation from the improvement of organizational processes and putting new products and services on the market. The government has as main responsibilities the formulation of policies favorable to innovation, that promote and facilitate the collaboration between the actors, and the support (financial or not) to the development of new technologies (Cavallini *et al.*, 2016). Government intervention has the potential to change the rules of the game and even create new markets (Etzkowitz and Leydersdorff, 1995). Therefore, academy, companies and government, acting together, can provide the necessary conditions for an integrated innovation ecosystem.

However, for the effective generation of value, society must also be part in the process of innovation. Thus, a new and more comprehensive model emerged, adding a fourth actor, civil society, and allowing a "bottom-up" approach. This model, called Quadruple Helix, maintains the interaction between the actors of the triple helix - academy, companies and government - and formalizes the participation of society in the innovation process to promote locoregional socio-economic development. Such a perspective allows territories to follow non-traditional paths of innovation, create new services, explore creativity, non-technological improvements and open innovation (Cavallini *et al.*, 2016).

The inclusion of civil society among the actors is especially relevant in innovation ecosystems, since it provides a better comprehension of the citizens' needs. In a context of increasing complexity, in which the transdisciplinarity and hybridization of knowledge become essential for the innovation process, the public interest must necessarily be considered in the process of discovery and generation of innovations that will promote social well-being (Yawson, 2009). With the fourth group of actors in the helix, innovation expands its technological focus and becomes a tool to overcome urban challenges through sustainable transformations (Borkowska and Osborne, 2018).

In this study, individual users who, as clients, citizens or members of a community, interact with academy, the government and companies, using, benefiting and assisting in the achievement of innovations that will contribute to their well-being and the socioeconomic development of the territory are considered members of civil society. Therefore, the quadruple helix requires an active participation of the members of civil society in the innovation process,

who must employ their knowledge, inventiveness and creativity, and provide constant feedback, so that the solutions generated are appropriate to their needs (Cavallini *et al.*, 2016). Therefore, in the quadruple helix model, society not only demands for new goods and services, but also becomes an active part in the innovation process (Etzkowitz and Leydersdorff, 2000).

This fourth group of the helix, however, requires the existence of mechanisms that support the effective involvement of citizens. Among the main means of fostering this participation are information and communication technologies (ICT). ICTs enable social inclusion in real time and at low cost (Cavallini *et al.*, 2016), in addition to exerting pressure and thus influencing institutional transformations and interaction between actors (Etzkowitz and Leydersdorff, 2000). The incorporation of elements such as ICTs, crowdsourcing and crowdfunding, among others, can even increase social networking capabilities, the dissemination of knowledge, the impact of discoveries and the likelihood of serendipity events happening. The quadruple helix, then, presents an explicit focus on the dynamically intertwined processes of coopetition, coevolution of different types of knowledge and co-specialization, in the context of territorial innovation ecosystems. This model also emphasizes a broader understanding of knowledge production, also paying attention to the integration of the public in the process of innovation (Carayannis *et al.*, 2018).

The actors of an innovation ecosystem are therefore distributed into four groups. To the Academy group are allocated institutions such as universities and other higher education and research institutions that contribute to the ecosystem mainly through the formation of human capital, and the production and dissemination of knowledge. In the Business group are included new companies (startups), large companies, science and technology parks, incubators and business accelerators, angel and venture investors and commercial banks, that is, the actors responsible for transforming knowledge into new products and solutions. The actors of the Government group are responsible for the institutional conditions that influence and guide the ecosystem; among these actors are the government bodies themselves, regulatory agencies and public development banks. Finally, the Civil Society group covers all individuals who assist in the process of innovation and benefit from it, such as the creative class, first users, professionals supporting innovation and entrepreneurship, popular icons, opinion formers, experienced entrepreneurs, family and friends.

In summary each actor of the innovation ecosystem has strategic resources and the relationship between them will give rise to the relational resources of the ecosystem. Therefore, this study presents a typology of categorization and analysis of the resources of an innovation

ecosystem similar to that of Barney (1997), which, based on a critical review of the literature, and in the context of the RBV, classifies the firm's internal resources in Financial, Human, Organizational and Physical Capitals. Thus, the resources of an innovation ecosystem belong to one of the following capitals: Intellectual, Financial, Structural, Institutional and Social.

Table 4 provides a summary of the key actors and resources of an innovation ecosystem. For the proper functioning of the ecosystem, the different actors, with different sets of resources, should maintain significant interdependence and do not necessarily need to be linked to contractual arrangements (Jacobides *et al.*, 2018); however, they need to find the right balance between weak ties, which facilitate adaptation and agility, and excessive decoupling, which can lead to instability, compromising the results of innovation (Dhanaraj and Parkhe, 2006). Accordingly, innovations will fail if there is no uniform distribution of value between these actors (Walrave *et al.*, 2018) and if coordination within the ecosystem is inadequate. This lack of formal structure increases the role of relational governance mechanisms (Valkokari, Seppänen, Mäntylä, and Jylhä-Ollila, 2017) and the orchestration of resources in the ecosystem.

Table 4: Summary of elements of an innovation ecosystem

TYPE	GROUP/CAPITAL	ELEMENTS
ACTORS	Academia	Universities and other institutions of higher education and research, centers of research and development, science and technology parks.
	Business	Startups, medium and large companies, business incubators and accelerators, angel and venture investors, and commercial banks.
	Government	Government bodies, regulatory agencies and development banks.
	Society	Creative class, first users, professionals supporting innovation and entrepreneurship, popular icons, opinion formers, experienced entrepreneurs, family and friends, Civil society associations and movements.
RESOURCES	Intellectual	High quality higher education; High quality management courses and schools; Entrepreneurship training and training programs; Qualified human capital; Academic spinoffs; Intellectual capital; Creativity; and Inventiveness.
	Financial	Angel capital; Seed capital; Venture capital; Microloans; Capital via debt; Strategic and Business Mentorship; Access to global markets, first customers, financial resources and networks.
	Structural	Access infrastructure (water, energy, transport, telecommunications and security); Patenting, licensing and commercialization of new technologies; Office services.
	Institutional	Legal, bureaucratic and regulatory frameworks conducive to innovation; public financial resources for innovation; Tax and tax incentives for new businesses; Innovation Culture; Success stories.
	Social	Mentoring; Contact networks; events.

Source: Authors

The first group of resources, Intellectual Capital focuses on the education of human capital and the availability of knowledge produced in the university. Skilled professionals, specialized technical training and support for research and development improve problem solving and are essential to innovation (Organisation for Economic Co-operation and Development, 2005). Moreover, a strategy that favors the territory to train, retain and attract talented and well-educated professional, results in a more entrepreneurial region (Zahra, Wright and Abdelgawad, 2014) and allows the ecosystem to compete globally (Camboim, Zawislak, and Pufal, 2019). Therefore, a high level of human capital is an imperative requisite for a successful ecosystem.

Just as the resources of Intellectual Capital form the basis for innovation to occur in ecosystems, the resources of the Financial Capital serve to finance innovation, such as that arising from new high-tech businesses. Financing of high-tech companies is considered a spatially limited phenomenon, with new ventures receiving investments mainly from local investors (Ghio, Guerini, and Rossi-Lamastra, 2019). While equity financing is an alternative to new business and sometimes even a strategic choice (Waleczek, Zehren, and Flatten, 2018), new ventures often need third-party capital.

The development of this capital is influenced by contextual factors, such as market size, population growth and urbanization density (Nicotra *et al.*, 2018). Thus, Business Capital underscores the need for financial resources not only available, but also visible and accessible for entrepreneurs to innovate (Stam, 2015). Well-developed financial markets reduce the cost of funding and assist in the flow of money, promoting greater development of the ecosystem (Kshetri, 2014).

Cities will thrive and grow if they provide attractive amenities and infrastructure to highly skilled people (Audretsch and Belitski, 2017). Thus, the Structural Capital relates to the access infrastructure and other structures to support innovation. Access infrastructure refers to water, energy, transportation, telecommunications and security conditions (Endeavor, 2017). Moreover, shared workspaces and spaces for innovation are also among the resources of this capital (Spigel, 2017).

Institutional Capital includes both formal institutional resources, such as laws, norms and regulations governing innovation in the ecosystem, and resources based on informal institutions, such as culture, trust between actors; tolerance to risk, failure and experimentation; and praise of research, creativity and innovation (Nicotra *et al.*, 2018). The institutional context influences the relations of cooperation and trust between the actors, and can exert influence on

knowledge transfer (Dyer and Hatch, 2006) and competitive advantage from relational resources (Dyer and Singh, 1998).

Finally, the resources of Social Capital emphasize the importance of relationships, especially among entrepreneurs, their peers, and other actors, such as family and friends. A high priority goal of any innovation ecosystem is the development of robust business and social networks (Bandera and Thomas, 2018), with a focus on creating new business opportunities or new knowledge (Valkokari *et al.*, 2017). The actors in this dimension can foster innovation mainly through the traffic of information about opportunities and insertion in relationship networks (Kotha and George, 2012); besides that, such resources can also lead to others, such as, for example, financial, provided by family, friends or other agents (Nicotra *et al.*, 2018; Waleczek *et al.*, 2018).

4. Orchestration of Resources in Innovation Ecosystems

The orchestration of resources in innovation ecosystems have the purpose of conducting a network of interdependent actors, leading them to combine complementary resources with the aim of co-creation and delivery of value, as well as the appropriation of the gains of this process, increasing the socio-technical viability of the ecosystem (Walrave *et al.*, 2018).

Orchestrating resources in an innovation ecosystem comprises the need to establish a balance between the shared vision and the self-interests of the actors of an innovation ecosystem, ensuring cooperation between them, in a role analogous to that of governance (Valkokari *et al.*, 2017). From the point of view of networks, ecosystems can present characteristics of both formal and informal governance (Dyer and Hatch, 2006; Autio and Thomas, 2014). Formal governance presupposes the existence of contracts, rules and regulations, while informal governance is conducted through the very structure of the network and the norms of reciprocity and trust, aspects that then support the relations between the actors (Provan *et al*., 2007).

Due to the organic nature of innovation ecosystems, there may not be a formalized governance, but an informal alignment between the actors will predominate. Informal mechanisms tend to be more effective than formal mechanisms to decrease transaction costs and increase knowledge sharing, consequently favoring cooperation (Dyer, Singh, and Hesterly, 2018). Hence, informal control devices as long as they are understood and legitimized

by the actors, should make the ecosystem efficient in the transfer of information and the dissemination of advances and innovative resources (Autio and Thomas, 2014).

For the effectiveness of informal coordination in an ecosystem, trust between actors is one of the main requirements, since it helps reduce transactional uncertainty and creates opportunities for the exchange of goods and services that are difficult to price or impose contractually. In addition, given its socially complex and idiosyncratic character to each relationship (Dyer and Singh, 1998), trust is also important because it increases access to resources and strengthens the ability of actors to adapt to unforeseen problems (Uzzi, 1996). Therefore, the atmosphere of trust in an innovation ecosystem should lead its actors to greater exchange of information and solutions to problem situations, since decision-makers tend to feel more protected from opportunistic behaviors (Jarillo, 1988). In ecosystems where the tendency of actors to behave opportunistically is greater, trust building is even more important (Ghio, Gherini and Rossi-Lamastra, 2019).

Similarly, the literature points out that ecosystems may or may not present a focal actor who will play the role of orchestrator. Considering the existence of this focal actor in the network, orchestration can be understood as the set of intentional and purposeful actions performed by him to create and extract value from the network. In this case, the focal actor can assess the value of relevant knowledge that resides in different points of the network and thus direct its transfer to other points where it is necessary, in addition to being able to learn and explore the resources generated in the network (Dhanaraj and Parkhe, 2006).

Although much of the literature recognizes the role of a focal actor that directs the efforts of others in the ecosystem (Dhanaraj and Parkhe, 2006; Autio and Thomas, 2014), for the purposes of this study, innovation ecosystems tend to resemble more typically to networks in which the organization and coordination between its actors occurs in an organic manner, without necessarily having an actor coordinating the actions and relationships between all the others. Thus, for phenomena in which there is a focal actor and whose objective is to analyze the set of elements and their interactions, the ecosystem approach, as treated here, may not be the most appropriate, since, when considering the existence of a focal actor, the organicity and the power distributed among the actors, two of the main characteristics of ecosystems, would be occluded. Therefore, innovation ecosystems are subject to the benefits and difficulties associated with a freer coordination system.

For the purpose of this study, informal coordination predominates in innovation ecosystems and there is not a focal actor that plays the role of coordinator. Understanding how

the coordination mechanism works is essential for the health and stability of an innovation ecosystem, since it drives collective performance by enabling and facilitating the creation and sharing of value (Autio and Thomas, 2014). Such a mechanism is the orchestration of actors and resources. Because of its complexity, orchestrating an innovation ecosystem requires considerable effort. Especially in the early stages of ecosystem development, it can be highly uncertain how effective cooperation between actors will be and what kind of dynamics and interdependencies will emerge. Thus, the development of the ecosystem requires a dialectical process of orchestration, in which learning is guided by both deliberate action and action feedback, mediated by the complexity of the situation and the interests of the ecosystem actors (Walrave *et al.*, 2018).

In this scenario, in which all actors pursue their own interests permanently, adopting an active and not a passive behavior, orchestration becomes even more important (Dhanaraj and Parkhe, 2006). By analyzing the relationships of the ecosystem as a whole, it is possible to mitigate discrepancies in the importance of individual actors or collective behavior. Therefore, orchestration can help to understand how collective benefits are generated from multilateral collaboration, improving the innovation process and improving the business climate in a region, making it more competitive (Provan *et al.*, 2007). In an innovation ecosystem, orchestration goes through the stages of network orchestration and relational resource orchestration. Network orchestration comprises the processes of knowledge mobility, innovation appropriability and network stability.

Dhanaraj and Parkhe (2006) argue that knowledge mobility serves to disperse the knowledge of each actor to all actors in the network. Individual knowledge-creating resources can be combined between each actor so that the result is innovation. Thus, it is extremely important that internal connections to the network are fostered, aiming for resources to be distributed beyond organizational boundaries, combined and deployed. Mobility also requires the development of knowledge absorption capacities (learning capacity at organizational boundaries), network identification (common values and beliefs, with the purpose of promoting cohesion, motivation and exchanges between members), and organizational socialization (formal and informal, with links, communication and relationships, aiming at the socialization of knowledge).

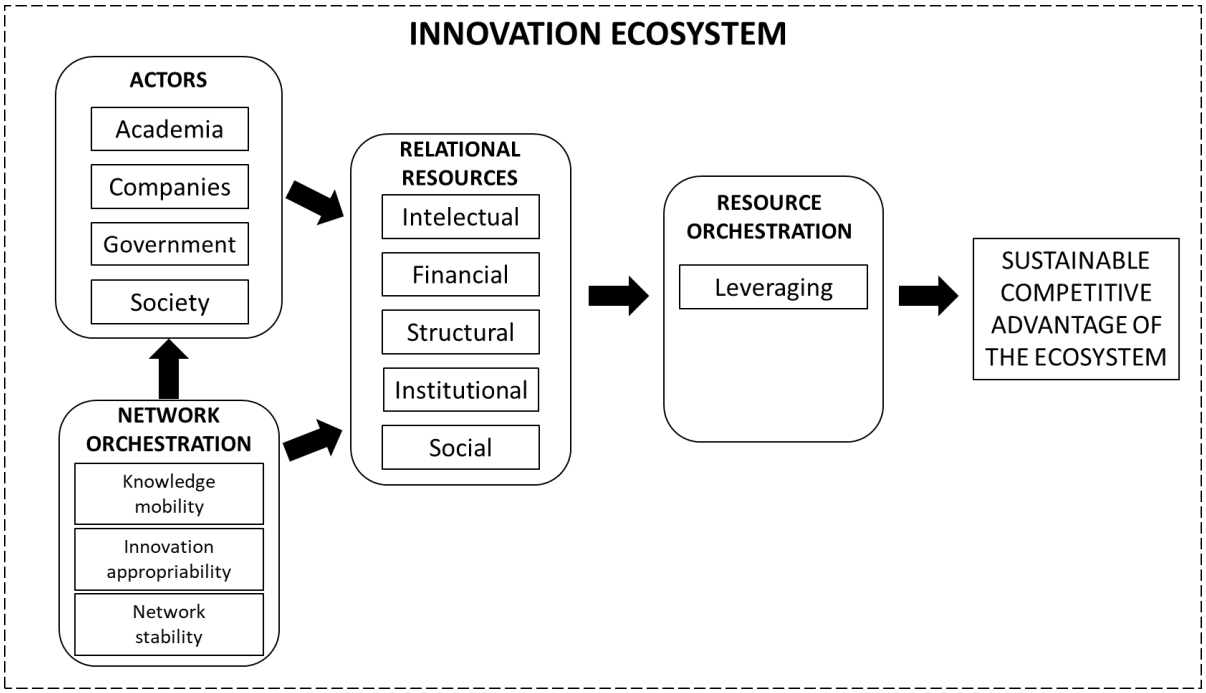
The innovation appropriability, on the other hand, aims to guarantee the uniform distribution of knowledge, while attenuating the perception of opportunism and appropriation of the network's knowledge by the actors without them delivering their best knowledge. The

innovation appropriability consists of three processes: trust (reciprocity, exchange of information, joint resolution of problems and sanctions for breach of trust), procedural justice (fairness of the decision-making process, bilateral communications, ability to refute decisions, full consideration of final decisions and consistency in the decision-making process) and joint ownership of assets (mutual commitment, joint problem solving and shared goals).

Finally, network stability aims to find balance between weak ties, which facilitate adaptation and agility, and excessive decoupling, which can lead to instability, compromising the results of innovation, and involves the following processes: improving the reputation, which discourages the breaking of ties, encourages the creation of new ties and promotes trust between actors; strengthen the interaction between the actors so that cooperation and reciprocity are encouraged in the future and this generates positive returns of expectation in the present, reflecting on the behavior of the actors; and creating multiplexity (two or more different relationships occurring concurrently), encouraging an ever greater interaction between the actors to strengthen the stability of the network (Dhanaraj and Parkhe, 2006).

After the orchestration of the network, the orchestration of the relational resources must happen. In an innovation ecosystem, the processes of structuring the portfolio of resources and aggregation of resources to build capabilities have already been overcome. In this case, the orchestration process starts with the leverage of resources to obtain sustainable competitive advantage. Therefore, in an innovation ecosystem the orchestration of relational resources can lead to the creation of value, innovation and, consequently, sustainable competitive advantage. Innovation ecosystems can create greater value than an organization could create individually. This value creation process requires coevolution, in which actors improve each other's capabilities, but this process requires coordination to be effective (Suominen, Seppänen, and Dedehayir, 2019). Thus, orchestration helps in the alignment between actors and the effective and efficient management of ecosystem resources; such elements will influence the amount of value (Sirmon, Hitt, and Ireland, 2007) that the ecosystem will generate over time. Figure 1 illustrates this process.

Figure 3. Resource Orchestration in Innovation Ecosystems



Source: authors

Innovation ecosystems are composed of several actors embedded in networks. Both the ecosystem itself and its actors, whether from the academy, companies, government or society, make available to the ecosystem resources of Intellectual, Financial, Structural, Institutional and Social capitals. Such resources, when made available to other ecosystem actors, can turn into relational resources, or network resources. Orchestration, through a collective strategy, allows both the ecosystem and its actors, individually, to exploit these resources and postulate superior performance and competitive advantage. Such resources are developed together, helping to influence and reproduce each other (Spigel, 2017); however, each ecosystem is unique and therefore resources can have distinct degrees of importance and require different capabilities in each of them for the achievement of sustainable competitive.

These findings support the applicability of Resource-Based View and relational and orchestration perspectives to the management of innovation ecosystems. Just as firms can reap benefits from relational resources, these same types of resources can be sources of sustainable competitive advantage for innovations ecosystems if properly orchestrated.

5. Conclusion

This theoretical essay argued that the orchestration of actors and relational resources,

through a collective strategy, can generate sustainable competitive advantage for an innovation ecosystem. To accomplish this objective, the literatures of innovation ecosystems and Resource-Based View, more specifically its unfolding through the Relational View, were taken as a basis. In the Resource-Based View, a firm holds a sustainable competitive advantage when it implements a strategy that is not replicable by competitors (Barney, 1991) and has resources that these competitors do not have access to (Kraaijenbrink, Spender, and Groen, 2010). The Relational View, in turn, emphasizes obtaining sustainable competitive advantage from strategic resources shared between partners in relationship networks (Dyer and Singh, 1998; Dyer and Hatch, 2006). From the relational perspective, the orchestration of actors and resources can help to explain the phenomenon of innovation ecosystems.

Innovation ecosystems can be understood as networks of actors and resources that together seek to promote innovation in different contexts. Thus, such environments result from the union of localized cultural perspectives, social networks, financial capital, universities, policies favorable to technological-based enterprises and civil society involvement in the innovation process. Thus, innovation ecosystems are defined by the connections between their actors, the resources of these relationships and the benefits that the articulation between them provides to innovators. Therefore, they are a critical tool to create resilient economies based on innovation (Spigel, 2017).

The interdependence between actors and resources, common both in the RBV – especially in the relational perspective – and in the ecosystem approach, denotes that, just as the set of actions taken by different individuals influences the performance of the firm (Molina-Azorín, 2014), the behaviors of different elements of an ecosystem and the relationships between them drive its performance. Therefore, analyzing the innovation ecosystems from the RBV, whose roots already pointed to the contrasts between the internal organization of the firm and its external environment (Wernerfelt, 1984), is in agreement with what Alvarez and Barney (2017) argue, for whom RBV applied to new contexts can become a source of wealth creation, becoming, for example, a unifying theory of fields analogous to innovation, such as, for example, entrepreneurship.

Thus, this theoretical essay sought to apply the assumptions of the Resource-Based View, and more specifically, its relational unfolding, to the analysis of innovation ecosystems. Furthermore, it provided a first effort to indicate the relationship between these literatures, which is also one of its main theoretical contributions, given that ecosystems are a new level and a new object of analysis for RBV and Relational View. Analyzing innovation ecosystems

through the RBV, the relational perspective, and the orchestration of actors and relational resources, from the identification, mobilization and exploitation of these resources through a collective strategy, can be a source of sustainable competitive advantage for the ecosystem.

For the purpose of moving forward with these findings, it would be relevant to carry out empirical studies, in order to test its main argument, seeking to verify in practice the main relational resources of an innovation ecosystem, also exploring how the actors can strengthen their resources, and how they relate to generate sustainable competitive advantage. Similarly, one can also look for the comparison between ecosystems at the same level – city, region, state, etc. – to verify which relational features are most relevant to each context and which configurations are most likely to generate sustainable competitive advantage. Quantitative studies can also help to identify and rank ecosystems comparatively.

References

Acs, Z. J., Szerb, L., & Autio, E. (2015). National systems of entrepreneurship. In Acs, Z. J., Szerb, L., & Autio, E. *Global Entrepreneurship and Development Index 2014* (pp. 13-26). Cham: Springer International Publishing. Retrieved from: https://link.springer.com/book/10.1007%2F978-3-319-14932-5. https://doi.org/10.1007/978-3-319-14932-5

Adner, R. (2017). Ecosystem as structure: An actionable construct for strategy. *Journal of Management*, *43*(1), 39-58. Retrieved from: https://journals.sagepub.com/doi/10.1177/0149206316678451 https://doi.org/10.1177/0149206316678451

Alvarez, S. A., & Barney, J. B. (2017). Resource-based theory and the entrepreneurial firm. *Strategic entrepreneurship: Creating a new mindset*, 87-105. Retrieved from: https://onlinelibrary.wiley.com/doi/abs/10.1002/9781405164085.ch5 https://doi.org/10.1002/9781405164085.ch5

Audretsch, D. B., & Belitski, M. (2017). Entrepreneurial ecosystems in cities: establishing the framework conditions. *The Journal of Technology Transfer*, *42*(5), 1030-1051. Retrieved from: https://link.springer.com/article/10.1007%2Fs10961-016-9473-8 https://doi.org/10.1007/s10961-016-9473-8

Autio, E., & Thomas, L. (2014). Innovation ecosystems. In: Dodgson, M., Gann, D. M., & Phillips, N. (Eds.). (2013). *The Oxford handbook of innovation management* (Chap. 11, pp. 204-228). Oxford: Oxford University Press.

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of management*, *17*(1), 99-120. Retrieved from: https://journals.sagepub.com/doi/10.1177/014920639101700108 https://doi.org/10.1177/014920639101700108

Barney, J. B., & Clark, D. N. (2007). *Resource-based theory: Creating and sustaining competitive advantage*. Oxford: Oxford University Press.

Barney, Jay B. (1997). *Gaining and sustaining competitive advantage*. Reading: Addison-Wesley Pub. Co.

Boari, C., & Lipparini, A. (1999). Networks within industrial districts: Organising knowledge creation and transfer by means of moderate hierarchies. *Journal of management and Governance*, *3*(4), 339-360. Retrieved from: https://link.springer.com/article/10.1023%2FA%3A1009989028605

Borgatti, S. P., & Foster, P. C. (2003). The network paradigm in organizational research: A review and typology. *Journal of Management*, *29*(6), 991-1013. Retrieved from: https://www.sciencedirect.com/science/article/abs/pii/S0149206303000874?via%3Dihub https://doi.org/10.1016/S0149-2063(03)00087-4

Borkowska, K., & Osborne, M. (2018). Locating the fourth helix: Rethinking the role of civil society in developing smart learning cities. Retrieved from: *International Review of Education*, *64*(3), 355-372. Retrieved from: https://www.sciencedirect.com/science/article/abs/pii/S0149206303000874?via%3Dihub https://doi.org/10.1007/s11159-018-9723-0

Camboim, G. F., Zawislak, P. A., & Pufal, N. A. (2018). *Driving elements to make cities smarter: Evidences from European projects. Technological Forecasting and Social Change.* Retrieved from: https://www.sciencedirect.com/science/article/abs/pii/S0040162517318607?via%3Dihub https://doi.org/10.1016/j.techfore.2018.09.014

Carayannis, E. G., Grigoroudis, E., Campbell, D. F. J., Meissner, D. & Stamati, D. (2018), The ecosystem as helix: an exploratory theory-building study of regional co-opetitive entrepreneurial ecosystems as Quadruple/Quintuple Helix Innovation Models. *R&D Management*, 48, 148-162. Retrieved from: https://onlinelibrary.wiley.com/doi/abs/10.1111/radm.12300 https://doi.org/10.1111/radm.12300

Cavallini, S., Soldi, R., Friedl, J., & Volpe, M. (2016). Using the quadruple helix approach to accelerate the transfer of research and innovation results to regional growth. *Consortium Progress Consulting Srl & Fondazione FoRmit*. Retrieved from: https://op.europa.eu/en/publication-detail/-/publication/6e54c161-36a9-11e6-a825-01aa75ed71a1

Dhanaraj, C., & Parkhe, A. (2006). Orchestrating innovation networks. *Academy of Management Review*, *31*(3), 659-669. Retrieved from: https://journals.aom.org/doi/10.5465/amr.2006.21318923 https://doi.org/10.5465/amr.2006.21318923

Dyer, J. H., & Singh, H. (1998). The relational view: Cooperative strategy and sources of interorganizational competitive advantage. *Academy of Management Review*, *23*(4), 660-679. Retrieved from: https://journals.aom.org/doi/10.5465/amr.1998.1255632 https://doi.org/10.5465/amr.1998.1255632

Dyer, J. H., Singh, H., & Hesterly, W. S. (2018). The relational view revisited: A dynamic perspective on value creation and value capture. *Strategic Management Journal*, *39*(12), 3140-3162. Retrieved from: https://onlinelibrary.wiley.com/doi/abs/10.1002/smj.2785 https://doi.org/10.1002/smj.2785

Endeavor (2017). Índice de cidades empreendedoras. Endeavor Brasil. Retrieved from https://endeavor.org.br/ambiente/indice-de-cidades-empreendedoras-2017/

Etzkowitz, H., & Leydesdorff, L. (1995). The Triple Helix - University-industry-government relations: A laboratory for knowledge based economic development. *EASST review*, *14*(1), 14-19. Retrieved from: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2480085

Etzkowitz, H., & Leydesdorff, L. (2000). The dynamics of innovation: from National Systems and "Mode 2" to a Triple Helix of university–industry–government relations. *Research Policy*, *29*(2), 109-123. Retrieved from: https://www.sciencedirect.com/science/article/abs/pii/S0048733399000554?via%3Dihub https://doi.org/10.1016/S0048-7333(99)00055-4

Fernandes, C.C., Oliveira Jr., M.d.M., Sbragia, R., and Borini, F.M. (2017), "Strategic assets in technology-based incubators in Brazil". *European Journal of Innovation Management*, *20*(1), 153-170. Retrieved from: https://www.emerald.com/insight/content/doi/10.1108/EJIM-04-2016-0043/full/html. https://doi.org/10.1108/EJIM-04-2016-0043

Florida, R. (2012). *The rise of the creative class - revisited: Revised and expanded*. New York: Basic Books.

Ghio, N., Guerini, M. & Rossi-Lamastra, C. (2019) The creation of high-tech ventures in entrepreneurial ecosystems: exploring the interactions among university knowledge, cooperative banks, and individual attitudes. *Small Business Economics* 52, 523–543. Retrieved from: https://link.springer.com/article/10.1007/s11187-017-9958-3 https://doi.org/10.1007/s11187-017-9958-3

Gulati, R. (1998). Alliances and networks. *Strategic Management Journal*, *19*(4), 293-317. Retrieved from: https://onlinelibrary.wiley.com/doi/10.1002/(SICI)1097-0266(199804)19:4%3C293::AID-SMJ982%3E3.0.CO;2-M https://doi.org/10.1002/(SICI)1097-0266(199804)19:4<293::AID-SMJ982>3.0.CO;2-M

https://doi.org/10.1023/A:1009989028605

Jacobides, M. G., Cennamo, C., & Gawer, A. (2018). Towards a theory of ecosystems. *Strategic Management Journal*, *39*(8), 2255-2276. Retrieved from: https://onlinelibrary.wiley.com/doi/full/10.1002/smj.2904. https://doi.org/10.1002/smj.2904

Jarillo, J. C. (1988). On strategic networks. *Strategic Management Journal*, *9*(1), 31-41. Retrieved from: https://onlinelibrary.wiley.com/doi/abs/10.1002/smj.4250090104 https://doi.org/10.1002/smj.4250090104

Kotha, R., & George, G. (2012). Friends, family, or fools: Entrepreneur experience and its implications for equity distribution and resource mobilization. *Journal of Business Venturing*, *27*(5), 525-543. Retrieved from: https://www.sciencedirect.com/science/article/abs/pii/S0883902612000365?via%3Dihub https://doi.org/10.1016/j.jbusvent.2012.02.001

Kraaijenbrink, J., Spender, J. C., & Groen, A. J. (2010). The resource-based view: a review and assessment of its critiques. *Journal of Management*, *36*(1), 349-372. Retrieved from: https://journals.sagepub.com/doi/10.1177/0149206309350775 https://doi.org/10.1177/0149206309350775

Kshetri, N. (2014). Developing successful entrepreneurial ecosystems. *Baltic Journal of Management*. Retrieved from: https://www.emerald.com/insight/content/doi/10.1108/BJM-09-2013-0146/full/html. https://doi.org/10.1108/BJM-09-2013-0146

Lavie, D. (2006). The competitive advantage of interconnected firms: An extension of the resource-based view. *Academy of Management Review*, *31*(3), 638-658. Retrieved from: https://journals.aom.org/doi/10.5465/amr.2006.21318922.

https://doi.org/10.5465/amr.2006.21318922

Molina-Azorín, J. F. (2014). Microfoundations of strategic management: Toward micro–macro research in the resource-based theory. *BRQ Business Research Quarterly*, *17*(2), 102-114. Retrieved from: https://www.sciencedirect.com/science/article/pii/S2340943614000206?via%3Dihub. https://doi.org/10.1016/j.brq.2014.01.001

Nicotra, M., Romano, M., Del Giudice, M., & Schillaci, C. E. (2018). The causal relation between entrepreneurial ecosystem and productive entrepreneurship: A measurement framework. *The Journal of Technology Transfer*, *43*(3), 640-673. Retrieved from: https://link.springer.com/article/10.1007%2Fs10961-017-9628-2. https://doi.org/10.1007/s10961-017-9628-2

Organisation for Economic Co-operation and Development. (2005). *Oslo manual: Guidelines for collecting and interpreting innovation data* (No. 4). Publications de l'OCDE. Retrieved from: https://ec.europa.eu/eurostat/web/products-manuals-and-guidelines/-/OSLO

Provan, K. G., Fish, A., & Sydow, J. (2007). Interorganizational networks at the network level: A review of the empirical literature on whole networks. *Journal of Management*, *33*(3), 479-516. Retrieved from: https://journals.sagepub.com/doi/10.1177/0149206307302554. https://doi.org/10.1177/0149206307302554

Rabelo, R. J., & Bernus, P. (2015). A holistic model of building innovation ecosystems. *IFAC-PapersOnLine*, *48*(3), 2250-2257. Retrieved from: https://www.sciencedirect.com/science/article/pii/S240589631500662X?via%3Dihub. https://doi.org/10.1016/j.ifacol.2015.06.423

Reynolds, E. B., & Uygun, Y. (2018). Strengthening advanced manufacturing innovation ecosystems: The case of Massachusetts. *Technological Forecasting and Social Change*, *136*, 178-191. Retrieved from: https://www.sciencedirect.com/science/article/abs/pii/S0040162517307680?via%3Dihub. https://doi.org/10.1016/j.techfore.2017.06.003

Schumpeter, J. A. (1982). *The theory of economic development: An inquiry into profits, capital, credit, interest, and the business cycle (1912/1934)*. New Jersey: Transaction Publishers.

Shaw, D. R., & Allen, T. (2018). Studying innovation ecosystems using ecology theory. *Technological Forecasting and Social Change*, *136*, 88-102. Retrieved from: https://www.sciencedirect.com/science/article/abs/pii/S0040162516307880?via%3Dihub. https://doi.org/10.1016/j.techfore.2016.11.030

Shipilov, A., & Gawer, A. (2020). Integrating research on interorganizational networks and ecosystems. *Academy of Management Annals*, *14*(1), 92-121. Retrieved from: https://journals.aom.org/doi/10.5465/annals.2018.0121. https://doi.org/10.5465/annals.2018.0121

Sirmon, D. G., Hitt, M. A., & Ireland, R. D. (2007). Managing firm resources in dynamic environments to create value: Looking inside the black box. *Academy of Management Review*, *32*(1), 273-292. Retrieved from: https://journals.aom.org/doi/10.5465/amr.2007.23466005. https://doi.org/10.5465/amr.2007.23466005

Sirmon, D. G., Hitt, M. A., Ireland, R. D., & Gilbert, B. A. (2011). Resource orchestration to create competitive advantage: Breadth, depth, and life cycle effects. *Journal of Management*, *37*(5), 1390-1412. Retrieved from:

https://journals.sagepub.com/doi/10.1177/0149206310385695. https://doi.org/10.1177/0149206310385695

Spigel, B. (2017). The relational organization of entrepreneurial ecosystems. *Entrepreneurship Theory and Practice*, *41*(1), 49-72. Retrieved from: https://journals.sagepub.com/doi/10.1111/etap.12167. https://doi.org/10.1111/etap.12167

Stam, E. (2015). Entrepreneurial ecosystems and regional policy: a sympathetic critique. *European Planning Studies*, *23*(9), 1759-1769. Retrieved from: https://www.tandfonline.com/doi/full/10.1080/09654313.2015.1061484. https://doi.org/10.1080/09654313.2015.1061484

Suominen, A., Seppänen, M. and Dedehayir, O. (2019), "A bibliometric review on innovation systems and ecosystems: a research agenda", *European Journal of Innovation Management*, Vol. 22 No. 2, pp. 335-360. Retrieved from: https://www.emerald.com/insight/content/doi/10.1108/EJIM-12-2017-0188/full/html. https://doi.org/10.1108/EJIM-12-2017-0188

Thomas, L. D., & Autio, E. (2020). Innovation Ecosystems in Management: An Organizing Typology. In *Oxford Research Encyclopedia of Business and Management*. Retrieved from: https://oxfordre.com/business/view/10.1093/acrefore/9780190224851.001.0001/acrefore-9780190224851-e-203. https://doi.org/10.1093/acrefore/9780190224851.013.203

Uzzi, B. (1996). The sources and consequences of embeddedness for the economic performance of organizations: The network effect. *American Sociological Review*, 674-698. Retrieved from: https://www.jstor.org/stable/2096399?origin=crossref&seq=1#metadata_info_tab_contents. https://doi.org/10.2307/2096399

Valkokari, K., Seppänen, M., Mäntylä, M., & Jylhä-Ollila, S. (2017). Orchestrating innovation ecosystems: A qualitative analysis of ecosystem positioning strategies. *Technology Innovation Management Review*, *7*(3). Retrieved from: https://timreview.ca/sites/default/files/article_PDF/Valkokari_et_al_TIMReview_March2017.pdf

Waleczek, P., Zehren, T., & Flatten, T. C. (2018). Start-up financing: How founders finance their ventures' early stage. *Managerial and Decision Economics*, *39*(5), 535-549. Retrieved from: https://onlinelibrary.wiley.com/doi/abs/10.1002/mde.2925. https://doi.org/10.1002/mde.2925

Walrave, B., Talmar, M., Podoynitsyna, K. S., Romme, A. G. L., & Verbong, G. P. (2018). A multi-level perspective on innovation ecosystems for path-breaking innovation. *Technological Forecasting and Social Change*, *136*, 103-113. Retrieved from: https://www.sciencedirect.com/science/article/abs/pii/S0040162517304997?via%3Dihub. https://doi.org/10.1016/j.techfore.2017.04.011

Wernerfelt, B. (1984). A resource-based view of the firm. *Strategic Management Journal*, *5*(2), 171-180. Retrieved from: https://onlinelibrary.wiley.com/doi/abs/10.1002/smj.4250050207. https://doi.org/10.1002/smj.4250050207

Yawson, R. M. (2009,). The ecological system of innovation: A new architectural framework for a functional evidence-based platform for science and innovation policy. In *The Future of Innovation Proceedings of the XXIV ISPIM 2009 Conference, Vienna, Austria*. Retrieved from: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1417676

Zahra, S. A., Wright, M., & Abdelgawad, S. G. (2014). Contextualization and the advancement of entrepreneurship research. *International Small Business Journal*, *32*(5), 479-500. Retrieved

from: https://journals.sagepub.com/doi/10.1177/0266242613519807. https://doi.org/10.1177/0266242613519807

Zen, A. C., & Fracasso, E. M. (2012). Recursos, competências e capacidade de inovação: um estudo de múltiplos casos na indústria eletro-eletrônica no Rio Grande do Sul. *RAI Revista de Administração e Inovação*, *9*(4), 177-201. Retrieved from: http://www.revistas.usp.br/rai/article/view/79294. https://doi.org/10.5773/rai.v9i4.877

4. PAPER III:

Orchestration of Actors and Resources for the Development of Innovation Ecosystems: an empirical perspective[4]

[4] This paper was approved for presentation at the EnANPAD 2022 Congress.

ABSTRACT

Within an innovation ecosystem, actors from the quadruple helix – academia, government, companies and society – must align their interests and engage in joint actions in order to exploit strategic resources and achieve competitiveness, which can happen through the orchestration of actors and relational resources. Hence, this paper aims to understand how actors and relational resources are orchestrated so that innovation ecosystems can achieve sustainable competitive advantage. For that purpose, we conducted exploratory qualitative research through document analysis, non-participant observation, and in-depth interviews with 20 actors from the Porto Alegre's innovation ecosystem in Brazil. This paper contributes to the literature mainly by highlighting the importance of relational resources in innovation ecosystems, exploring the role of the orchestration of actors and resources in creating sustainable competitive advantage for ecosystems, and validating a framework for researchers to analyze different innovation ecosystems and for practitioners to drive the ecosystems towards better development and the achievement of sustainable competitive advantage.

Keywords: Innovation Ecosystem; Network Orchestration; Resource Orchestration; Relational View; Sustainable Competitive Advantage.

1. Introduction

Innovation ecosystems (IEs) are important drivers for the execution of local and regional development strategies since all actors depend on the environment for competitiveness and survival (Pfeffer and Salancik, 2003). These environments seek to encourage collaboration between actors and create the ideal conditions for innovation to take place. Thus, innovation ecosystems can foster innovation in a territory, bringing together the key actors and resources to the innovative process. Therefore, the promotion of IE is one of the most important strategies for local and regional socioeconomic development.

A territorial approach argue that innovation ecosystems refer to a specific place and put emphasis on externalities such as the sense of community, trust, coopetition, stakeholder engagement, synergies, uncertainty reduction, economics of scale/scope, and innovation outcomes (Scaringella and Radziwon, 2018). Hence, the evolution of an innovation ecosystem can both be influenced and benefit by the location to which it is related, such as a city.

Cities account for 80% of the world's gross domestic product (GDP) and approximately 55% of the world population reside in them, a number that tends to increase to 70% by 2050 (World Bank, 2020b). Cities also reunite several features that are favorable to innovation, such as proximity, density, and variety of actors. Moreover, they gather and mobilize resources such as people, ideas, spaces, solutions, and new technologies (UNIDO, 2019). Thus, they make it possible for innovation to become increasingly open and to occur organically, facilitating the use of benefits arising from the agglomeration of actors and having critical importance for socioeconomic development (Mulas, Minges, and Applebaum 2016).

Innovation ecosystems at the city level stress the importance of fostering connections and partnerships between the actors of the quadruple helix – academia, government, companies, and society (UNIDO, 2019). These actors may have conflicting interests but they must also share common interests and behaviors aiming at a win-win situation so the ecosystem can benefit from their relationships (Santos, Zen, and Bittencourt, 2021). Hence, actors can compete and collaborate at the same time, so the innovation ecosystem can be fulfilled and exploit its relational resources.

The orchestration of these relational resources drives the ecosystem to development and ensure greater regional competitiveness. The relational perspective considers the benefits generated together by actors (Dyer and Singh, 1998) and network structure (Fernandes et al., 2017). Innovation ecosystems endowed with strategic relational resources and the capability to

effectively exploit them can gain an advantage over others ecosystems that do not have the same resources or are incapable of exploiting them properly.

Therefore, just as important as to have actors sharing common interests, access to resources is critical in generating innovation and, consequently, in obtaining competitive advantage in highly competitive, increasingly complex, dynamic and uncertain environments. However, just believing that individual interests are self-regulating and that the mere availability of relational resources will assure success is not enough to guarantee the alignment of interests and the effective exploitation of that. Just as important as owning resources is the use that will be made of them (Sirmon, Hitt, and Ireland, 2007; Sirmon et al., 2011). A proper orchestration provide opportunity to generate new ideas, improve productivity, foster innovation (World Bank, 2020b) and is critical for the development of innovation ecosystems.

This paper aims to analyze how actors and relational resources are orchestrated so that innovation ecosystems can achieve sustainable competitive advantage (SCA). In an innovation ecosystem, SCA occurs when the ecosystem implements a value creation strategy that is not being simultaneously implemented by any other ecosystem and when other ecosystems are not able to replicate the benefits of this strategy (Barney, 1991; Hitt, Ireland, and Hoskisson, 2017). SCA can result from relationships between a network of actors and the exploitation of resources generated by them together (Dyer and Singh, 1998; Lavie, 2006). Although no SCA can last forever, this is still a relevant strategic concept (Kraaijenbrink, Spender, and Groen, 2010).

The ecosystem approach consists on a singular and distinct field that deserves scientific investigation. Moreover, there is also a gap on how to effectively manage an ecosystem (Gomes et al., 2021). Hence, this research aims to contribute to the literature through new insights. To explore this theme and achieve the proposed objective, we chose the innovation ecosystem of Porto Alegre, Brazil as the locus of our research. Porto Alegre has the seventh-largest Gross Domestic Product (GDP) in Brazil and around 1,4 million inhabitants (IBGE, 2020). The city has transformed itself in recent years and has placed innovation as one of the pillars of its development strategy. Several movements, programs and initiatives embraced by actors of the quadruple helix (Zen et al., 2019, Santos, Zen, and Faccin, 2020) have sought to dynamize the local economy through open innovation (Chesbrough, 2003) strategies aimed at training, retaining and attracting talent, as well as encouraging the development of innovative solutions and the improvement in quality of life.

In the next sections, we present the theoretical background on innovation ecosystems in cities, the role of the quadruple helix actors, and how they and the ecosystem's relational

resources are orchestrated. We also present the literature on Orchestration of Actors and Resources, focusing on the framework developed by Santos and Zen (2020). In the following sections, we present the Method, Results, Discussion, and Conclusion.

2. Innovation ecosystems in cities and the role of the quadruple helix

Innovation ecosystems can be seen as meta-organizations that "encompasses the design, planning, and management of all activities related to distributed value creation and capture concerning a systemic innovation for a target audience" (Gomes et al., 2021, p. 2). They are open, dynamic, (Rabelo, and Bernus, 2015), evolutionary, complex, and systemic environments (Thomas, Sharapov, and Autio, 2018) composed of non-hierarchical networks of co-creative and interdependent actors (Suominen, Seppanen, and Dedehayir, 2018; Walrave et al., 2018) interconnected by multilateral ties (Borgatti & Foster, 2003; Provan, Fish & Sydow, 2007) through a wide range of social and economic relations (Uzzi, 1996; Gulati, 1998) that interact, share and exploit resources in order to promote innovation.

Innovation ecosystems in cities emphasize a systemic approach for territories to generate sustained competitive advantage, given competition now is not only between firms but between different ecosystems (Cennamo and Santalo, 2019). Thus, IEs are especially valuable in assisting a territory to achieve competitiveness through the conscious intervention of actors who play complementary roles (Thomas, Sharapov, and Autio, 2018). The first step for such ecosystems to strive in achieving a sustainable competitive advantage is the identification of its main actors and strategic resources, which can be grouped according to Table 5.

Table 5: Summary of elements of an innovation ecosystem

TYPE	GROUP/CAPITAL	ELEMENTS
ACTORS	Academia	Universities and other institutions of higher education and research, centers of research and development, science and technology parks.
	Business	Startups, medium and large companies, business incubators and accelerators, angel and venture investors, and commercial banks.
	Government	Government bodies, regulatory agencies and development banks.
	Society	Creative class, first users, professionals supporting innovation and entrepreneurship, popular icons, opinion formers, experienced entrepreneurs, family and friends, Civil society associations and movements.
RESOURCES	Intellectual	High quality higher education; High quality management courses and schools; Entrepreneurship training and training programs; Qualified human capital; Academic spinoffs; Intellectual capital; Creativity; and Inventiveness.
	Financial	Angel capital; Seed capital; Venture capital; Microloans; Capital via debt; Strategic and Business Mentorship; Access to global markets, first customers, financial resources and networks.
	Structural	Access infrastructure (water, energy, transport, telecommunications and security); Patenting, licensing and commercialization of new technologies; Office services.
	Institutional	Legal, bureaucratic and regulatory frameworks conducive to innovation; public financial resources for innovation; Tax and tax incentives for new businesses; Innovation Culture; Success stories.
	Social	Mentoring; Contact networks; events.

Source: Santos and Zen (2020)

There are four groups of actors in an innovation ecosystem: academia, companies, government and society. The interaction between them can contribute to regional development through the creation, diffusion and application of new knowledge, new technologies and, ultimately, through the capture and delivery of economic and social value (Cavallini, Soldi, Friedl, and Volpe, 2016).

Helix approaches emphasize the importance of interaction between the academia, companies and government, entities that form the triple helix, in addition to civil society (fourth "blade" of the helix) for the purpose of generate innovation. The Quadruple Helix model asserts that innovation is the outcome of the interplay between the actors on the production side, i.e., academia, government, and companies (Etzkowitz and Leydersdorff, 1995), and actors from the user side - society (Carayannis and Campbell, 2009, Carayannis et al., 2018).

However, no territory is equal to another and there is no unique recipe nor an ideal configuration of innovation ecosystem for all territories. Regional development is based on path dependence (Martin and Sunley, 2006) and each territory has its own history (Karlsen and

Larrea, 2014), Thus, it is impossible to replicate the same ecosystem from one location to another, such as Silicon Valley, for example (Isenberg, 2010). Each innovation ecosystem is influenced by different contextual conditions and present its own idiosyncrasies, identity (Scaringella and Radziwon, 2018; Walrave et al., 2018) and resources.

The geographically bounded nature of innovation ecosystems in cities provides access to tangible and intangible resources. Its territorial roots allow the agglomeration (Martins et al., 2019) and proximity between actors, which can encourage co-creation (Presutti, Boari and Majocchi, 2013) and open innovation processes, the transfer of tacit knowledge, and engaging in partnerships. Moreover, co-location effects promote the concentration (Jacobides et al., 2018; Thomas, Sharapov, and Autio, 2018) and better access to complementary resources in the environment, which favors the sharing of resources between actors and the building of relational resources (Dyer, Singh, and Hesterly, 2018), which are paramount in innovation processes (Oliveira Jr., Cahen, and Borini, 2019b).

The environment and the different actors of an innovation ecosystem, whether from academia, business, government or society, make resources of Intellectual, Business, Structural, Institutional and Social capital available to the ecosystem. The relational resources are made possible by complementary resources, which are the distinctive resources of actors that collectively generate higher incomes than that the sum of incomes obtained through the individual resources of each partner (Dyer and Singh 1998; Dyer, Singh, and Hesterly, 2018). Such resources, when combined or made available to other actors in the ecosystem, can become relational resources, or network resources. The orchestration of these resources, through a collective strategy, allows both the ecosystem and its individual actors to exploit them and postulate superior performance and competitive advantage. Such resources develop together, helping to influence and reproduce each other (Spigel, 2017). However, each ecosystem is unique and, therefore, resources can have different degrees of importance and require different capabilities in each of them so that sustainable competitive advantage can be achieved.

Relational resources can drive the ecosystem to achieve a competitive advantage as long as they are identified and mobilized by the actors, who must develop a collective strategy that allows them to be exploited. In innovation environments, the relational resources can be more effective than simply the provision of individual resources, such as physical infrastructure and services (Fernandes et al., 2017).

One of the questions to be made is if innovation ecosystems can be managed (Gomes et al., 2021) in order to achieve sustainable competitive advantage. We argue that the orchestration

of actors and resources is a coordination mechanism used to manage innovation ecosystems and achieve SCA.

3. Orchestration of Actors and Resources in Innovation Ecosystems

The coordination of innovation ecosystems ensures the value creation process and the coevolution, in which actors improve each other's capabilities (Suominen et al., 2018). Understanding how the ecosystem coordination works is essential for its health and stability, as it drives collective performance by enabling the cocreation and sharing of value (Autio and Thomas, 2014). The emergence of an innovation ecosystem occurs when actors decide to align and integrate resources in order to achieve an innovation and reduce the governance costs as the creation of value is distributed between them (Gomes et al., 2021). Actors compete but also cooperate (Shaw and Allen, 2016) and must align their interests through continuous processes of reflection, discussions, and negotiations (Etzkowitz and Leydersdorff, 2000) in order to cocreate value and innovate. Therefore, innovation ecosystems can create greater value than an individual organization by itself.

Orchestration is a coordination strategy that improves collaboration between actors and help the innovation ecosystem to achieve sustainable competitive advantage through the exploitation of relational resources. The orchestration strategy involves several management activities, such as the need to establish a balance between the shared vision and the self-interests of its actors, ensuring cooperation between them (Valkokari et al., 2017), establishing rules, and aligning interests and objectives between actors. It also provides the effective and efficient management of ecosystem resources, since such elements will influence the amount of value (Sirmon, Hitt, and Ireland, 2006; Shi and Shen, 2021) that the ecosystem will generate over time.

This strategy must lead the network of interdependent actors of an innovation ecosystem to combine complementary resources and get involved in co-creation processes to deliver and extract value, increasing the socio-technical viability of the ecosystem (Walrave et al., 2018). Therefore, for the proper functioning of an innovation ecosystem, both actors and resources must be orchestrated in order to achieve the intended objectives.

Orchestrating an innovation ecosystem requires considerable effort because of its complexity. Depending on its stage of maturity, ecosystems may have one or multiple actors

playing the role of orchestrators. Particularly in the early stages of ecosystem development, it can be highly uncertain how effective the cooperation between actors will be and what kind of dynamics and interdependencies will emerge. Thus, the development of the ecosystem requires a dialectical process of orchestration, with learning guided by both deliberate action and feedback from actions, mediated by the complexity of the situation and the interests of the actors involved (Walrave et al., 2018).

Orchestration also depends on actors who play leadership roles. Key members of an ecosystem can influence the behavior of other players (Rietveld and Schilling, 2020). The role of orchestrators is to perform intentional and purposeful actions to direct efforts of others (Autio and Thomas, 2014), and create and extract value from the network, assessing the value of relevant knowledge that resides in different points of the network and transferring it to other points where it is needed, in addition to being able to learn and explore the resources generated in the network (Dhanaraj and Parkhe, 2006).

In an innovation ecosystem, orchestration goes through the stages of network orchestration and resource orchestration. Actors are arranged in networks, and thus network orchestration comprises the processes of managing knowledge mobility, managing innovation appropriability, and managing network stability (Dhanaraj and Parkhe, 2006).

The mobility of knowledge makes the knowledge of each actor to be dispersed to all actors in the network. Individual knowledge-creating resources can be combined between each actor so that the output is an improved innovation. For this, it is extremely important that the connections inside the network are fostered, aiming at those resources are distributed across organizational boundaries, combined and deployed. Mobility also requires the development of knowledge absorption capacities (ability to learn across organizational boundaries), network identification (common values and beliefs, with the purpose of promoting cohesion, motivation and exchanges among members), and organizational socialization (formal and informal, with links, communication and relationships, aiming at the socialization of knowledge) (Dhanaraj and Parkhe, 2006).

Innovation appropriability, on the other hand, aims to ensure the uniform of knowledge, while at the same time attenuating the perception of opportunism and appropriation of knowledge from the network by the actors without them delivering their best knowledge. The appropriation of knowledge consists of three processes: trust (reciprocity, exchange of information, joint problem solving and sanctions for breach of trust), procedural justice (justice in the decision process, bilateral communications, ability to refute decisions, full consideration

of final decisions and consistency in the decision-making process) and joint ownership of assets (mutual commitment, joint problem solving and shared goals) (Dhanaraj and Parkhe, 2006).

Finally, network stability involves finding a balance between weak ties, which facilitate adaptation and agility, and excessive decoupling, which can lead to instability, compromising the results of innovation. In this case, orchestration involves the following processes to guarantee the stability of the network: improving reputation, which discourages the breaking of ties, encourages the creation of new ties and promotes trust between actors; lengthen the "shadow of the future", that is, strengthen the interaction between the actors so that cooperation and reciprocity are encouraged in the future and this generates positive returns of expectation in the present, reflected in the actors' behavior; and create multiplexity (two or more different relationships occurring at the same time), encouraging an increasing interaction between actors to strengthen the stability of the network (Dhanaraj and Parkhe, 2006).

After network orchestration, there must be orchestration of relational resources. The Relational View considers that sustainable competitive advantage can result from relationships between a network of firms. The applicability of the Resource-Based Vision and the relational and orchestration perspectives to innovation ecosystems is relevant. Just as firms can benefit from relational resources, these same types of resources can be sources of competitive advantage for ecosystems if properly orchestrated.

According to Sirmon et al. (2011), the resource orchestration occurs through three processes, for each of which there are three other sub-processes. These processes and sub-processes are: structuring (acquisition, accumulation and disinvestment); bundling (stabilization, enrichment and pioneering); and leveraging (mobilization, coordination and implementation).

Structuring involves the the acquisition, accumulation and divestment of resources to make up the resource portfolio. Acquisition refers to the purchase of tangible or intangible resources in the market, which can increase the potential to create value. Accumulation, on the other hand, depends heavily on learning and is related to the internal development of resources, when the market cannot provide them. Finally, the disinvestment sub-process considers the need to constantly reassess the current and future potential of generating value from resources, with the purpose of disinvesting those with low potential, thus opening space for the focus on resources with the greatest potential (Sirmon, Hitt, and Ireland, 2007).

The bundling process, in turn, refers to the integration of resources to form capabilities, comprising the stabilization, enrichment and pioneering sub-processes. Stabilization refers to

small incremental improvements to existing capabilities. Enrichment is about expanding current capabilities by learning new skills and adding new features to the current portfolio. Pioneering spirit is the sub-process of creating new capabilities through the integration of new, possibly unrelated, resources in the portfolio, using creativity and a deep knowledge base for this (Sirmon, Hitt, and Ireland, 2007).

Finally, leverage highlights processes chained in sequence with the purpose of exploiting the company's resources and taking advantage of specific market opportunities. In leverage, the subprocesses of "mobilization" are included, which provides a plan or vision regarding the resources needed to form necessary capability configurations; "coordination", which involves the integration of capability settings; and "deployment", in which a resource advantage, market opportunity or entrepreneurial strategy is used to explore the capability settings formed by the coordination subprocess (Sirmon et al., 2011).

In a city innovation ecosystem, the relational resources already structured and bundled should be leveraged (Sirmon et al., 2011) for the ecosystem to create value, achieve innovation, and obtain sustainable competitive advantage.

In this scenario, in which all actors permanently pursue their own interests, without adopting a passive behavior, orchestration becomes even more important (Dhanaraj and Parkhe, 2006). Analyzing the relationships of the ecosystem as a whole, it is possible to mitigate discrepancies in the importance of individual actors or collective behavior. Therefore, orchestration can help to understand how collective benefits are generated from multilateral collaboration, improving the innovation process and improving the business climate in a region, making it more competitive (Provan, Fish, and Sydow, 2007). Moreover, orchestrating relational resources is a value creation strategy that drives the ecosystem to obtain sustainable competitive advantage, as their dynamic deployment is as important as the possession of them (Zheng, Talavaei, and Khan, 2021).

4. Method

The purpose of this article is to analyze how actors and relational resources are orchestrated so that innovation ecosystems achieve sustainable competitive advantage. For that, case study research was conducted on the innovation ecosystem of Porto Alegre – RS. According to the ranking Índice de Cidades Empreendedoras (Endeavor and Enap, 2020), Porto

Alegre is among the ten more entrepreneurial and innovative Brazilian cities and is considered a reference for its history of balance between innovation, quality of life, interaction between actors, incentive policies and economic development. We chose the case study as it allows the researcher to carry out a deep, detailed and exhaustive investigation of a phenomenon within its real context, being widely used in the social sciences (Gil, 2002).

For data collection, we employed the techniques of document analysis, non-participant observation, in-depth interviews, and triangulation. Document analysis is based on documents, records, materials and artifacts to help the researcher in understanding the central phenomenon of the study. Through it, the researcher can know the background of an environment, experiences or everyday situations (Sampieri, Collado and Lucio, 2013). In order to achieve our goals, news from newspapers, news and institutional websites were analyzed, as well as videos, podcasts, reports and materials from in-person and online meetings of the actors in the Porto Alegre innovation ecosystem.

On the other hand, the observation technique aims to explore and describe different contexts, their activities and people; understand processes, experiences, circumstances and patterns; identify problems; and generate hypotheses. Observation is the only technique that permeates all qualitative studies and is used especially when to collect data on phenomena, themes or situations that are difficult to discuss or describe, when participants are not able to adequately express their ideas, when the researcher is unfamiliar with the phenomenon to be investigated, and for the confirmation of interview data (Sampieri, Collado and Lucio, 2013).

The observations took place in ecosystem events in which the actors of the quadruple helix participated, such as lectures, meetings and workshops, between 2018 and 2019. In-depth interviews were carried out at a later time, with 20 experts in the ecosystem, including five representatives from universities, five government representatives, five society representatives and five business representatives.

The balance between the quadruple helix (there should be the same number of interviewees in each of the groups of actors, in order to mitigate any biases), the representativeness and experience of each interviewee in the ecosystem, as well as the snowball technique for indications among the experts of possible interviewees were used as criteria for choosing the interviewees. Each group of the helix had 5 interviewees, experts in the innovation ecosystem of Porto Alegre.

Another important point to be highlighted is that the interviewees participate or have participated in open innovation initiatives with the other actors of the quadruple helix, either

individually or representing their organization. Hence, most of the interviewees simultaneously played, at the time of the interview, more than one role in the ecosystem. For example, INT2 is at the same time a professor at a public university and coordinator of the Pacto Alegre movement. INT14 is a partner in a technology company, CEO in a startup, and startup mentor. INT16 is the leader of a collective movement of civil society and creative industry entrepreneur. The main role of each respondent in the ecosystem was considered for their allocation to one of the helix groups - academia, government, companies or civil society. Due to the Covid-19 pandemic all interviews were carried out through virtual platforms between the months of March and November 2021. Table 7 shows the profile of each of the 20 interviewees of this research.

Table 6: Profile of the Intervewees

Code of Interviewee	Helix Group	Interviewee Position	Interview duration
INT1	Academia	Full professor and former director of a Science Park	00:52:57
INT2	Academia	Full professor and coordinator of Pacto Alegre	00:57:11
INT3	Academia	Innovation and development superintendent	00:57:12
INT4	Academia	Executive manager at a Science Park	00:36:46
INT5	Academia	President at a private university	00:39:09
INT6	Government	Advisor at the Porto Alegre City Hall	00:43:46
INT7	Government	Advisor at the Porto Alegre City Hall	01:36:36
INT8	Government	Communication Coordinator at the Porto Alegre City Hall	00:48:53
INT9	Government	Adviser for Venture Capital and Innovation in a development bank	01:10:29
INT10	Government	Director of Innovation at the Porto Alegre City Hall	00:40:17
INT11	Companies	CEO at a startup	00:36:54
INT12	Companies	CEO at a startup	01:16:09
INT13	Companies	CEO at a startup	01:10:00
INT14	Companies	Partner in a tech company, CEO of a startup, and startup mentor	00:41:56
INT15	Companies	Founder and CEO in a tech company	00:51:23
INT16	Society	Leader of a collective movement for the transformation of Porto Alegre and entrepreneur in the creative industry	01:23:34
INT17	Society	Manager of innovation projects at a support organization	00:27:05
INT18	Society	Local leader of a global entrepreneurship movement	01:16:09
INT19	Society	President at the local Association of Startups	00:49:29
INT20	Society	Director of a collaborative project of place branding for Porto Alegre	00:38:20

Source: Authors

Respondents, as recommended by Hair et al. (2003), were experts on the subject of the interview, in this case, the innovation ecosystem of Porto Alegre. For the in-depth interviews, the interviewer prepares a plan to guide the interviews and the answers are not structured. This technique is understood as the most suitable for the purpose of this article because it allows a deeper investigation into the subject to be approached (Hair et al., 2003). The script used for

the research is presented in Appendix A of this paper and was validated by another previous research (Santos et al., 2021), in which there were nine respondents from one regional innovation ecosystem in Brazil. After all the collection of evidences, we used the triangulation strategy, which aims at using multiple sources of evidence to validate and verify the accuracy of the collected data (Creswell, 2014).

For the treatment of collected data, we used the content analysis technique, which have three sequential stages: pre-analysis; exploration of the material; and treatment of results, inference and interpretation. The first stage, pre-analysis, is characterized by the systematization of ideas, through the organization of the material. The next step, exploration of the material, consists of defining categories of analysis and identifying the units of record and context in the documents. The last step, treatment of results, inference and interpretation is when the interpretation of results takes place, through reflective and critical analysis (Bardin, 1977).

The data analysis of the paper was performed from analysis categories previously constructed based on the literature review. We consider that the “ecosystem orchestration” construct is comprised of innovation network orchestration and resource orchestration used the following dimensions of analysis (Table 6):

Table 7: Dimensions of Analysis

Ecosystem Orchestration	Process	Subprocess	Authors
Innovation Network Orchestration	Knowledge mobility	Development of knowledge absorption capacities	Dhanaraj & Parkhe (2006)
		Network identification	
		Organizational socialization	
	Innovation appropriability	Trust	
		Procedural justice	
		Joint property of assets	
	Network stability	Enhance reputation	
		Lengthen the "shadow of the future"	
		Create multiplexity	
Resource Orchestration	Leverage	Mobilization	Sirmon *et al.* (2011)
		Coordination	
		Deployment	

Source: authors

Thus, the orchestration of the ecosystem was analyzed in two stages, one considering the orchestration of the network, with three processes and nine subprocesses, and the other considering the orchestration of resources, the process of leveraging them and their three inherent subprocesses. The results and discussion are presented in the following section.

5. Results and Discussion

The innovation ecosystem of the city of Porto Alegre was chosen to be the object of this research due to its recent protagonism - for example, in 2022 it will host the South Summit, one of the main world events of entrepreneurship and innovation (Yahoo, 2022). Porto Alegre has an estimated population of approximately 1.4 million inhabitants, being the tenth largest in Brazil and the seventh largest economy, with a Gross Domestic Product (GDP) of R$ 73.4 billion (IBGE, 2019). Porto Alegre's Gross Domestic Product (GDP) worth R$ 73.5 billion, the seventh-largest in Brazil, corresponding to a GDP per capita of approximately R$ 49.5 thousand per year (IBGE, 2019).

Porto Alegre has a thriving innovation ecosystem and a vibrant entrepreneurship ecosystem. The city is the main reference of a state (Rio Grande do Sul) that has the third largest number of startups mapped in Brazil (952, behind São Paulo and Minas Gerais), according to the database of the Brazilian Association of Startups (Startup Base, 2021). Moreover, in relation to the state of Rio Grande do Sul, Porto Alegre also stands out in terms of smart specialization strategy to foster innovation ecosystems. The city belongs to the Metropolitan and North Coast region of the Inova RS Program, whose vision of the future aims to make this region a global reference in the strategic areas of Health, Education, Creative Economy and Information and Communication Technology – ICT (Governo do Estado do Rio Grande do Sul, 2021).

Porto Alegre also stands out for its universities of excellence. Universities are central actors in an innovation ecosystem, as they influence the processes of absorption and dissemination of knowledge, in addition to connecting local actors to the ecosystem (Schaeffer et al., 2018). Since 2018, Porto Alegre has an articulation between its three main universities called Aliança para Inovação (Alliance for Innovation, as translated by the authors). This articulation aims to leverage high-impact actions for the development of the city's innovation ecosystem and to impact on local and regional development, transforming this ecosystem into an international reference in the environment of innovation, knowledge and entrepreneurship (Aliança para Inovação, 2021). Next, we present the results from the research.

5.1 Innovation Network Orchestration

In relation to knowledge mobility, the development of knowledge absorptive capacity is mainly encouraged through the gathering of actors in collaborative events and projects for

the development of the ecosystem. The absorptive capacity is the organization's dynamic ability to manage external knowledge and can lead to value creation and competitive advantage (Camisón and Forés, 2010).

Despite facing cultural obstacles, mainly related to the construction of trust among actors, which still lacks strengthening, as the ecosystem evolves, there is more openness to open innovation, with the acquisition of knowledge of other actors, benchmarking and development of new internal skills (Camisón and Forés, 2010). In the innovation ecosystem of Porto Alegre, one of the examples is the Dito Efeito, mentioned by INT15 and which consists of events for networking and knowledge sharing by the actors of the innovation ecosystem of Porto Alegre. Dito Efeito (uMov.me, 2021) started in face-to-face format and, with the Covid-19 pandemic, it became online.

Porto Alegre actors are also more easily engaged as they create a common identity and believe in it. Pacto Alegre itself and the place branding project "O que marca POA?" (What is the brand of POA?), mentioned by INT20, are responsible for creating and reinforcing a common identity. This project, which culminated in the choice of the Porto Alegre brand, was developed voluntarily and collaboratively by local professionals and involved more than 10,000 people from civil society in the public listening process. The project "What makes POA?" has received great attention in the local media and is seen by leaders as an effective and successful example of co-creation among the actors of the quadruple helix (Gauchazh, 2022). A shared identity provides increased levels of trust, motivation, and cohesion needed to share knowledge on the network (Dhanaraj and Parkhe, 2006).

Also in relation to the mobility of knowledge, the socialization of knowledge is also promoted by the actors of the innovation ecosystem and Porto Alegre. When face-to-face events took place, especially under the Pacto Alegre, such as the workshops that took place to map the ecosystem and identify challenges (Santos, Zen, and Faccin, 2020), there was always a lot of networking, according to the interviewees. Despite the fact that face-to-face events have ceased to occur due to the pandemic of Covid-19, new moments of knowledge exchanges have been established online, such as the meetings of the Pacto Alegre's "Mesa" and projects such as the Dito Efeito, already mentioned above.

In turn, the appropriation of innovation must have as one of its subprocesses the trust. The role of trust in the development of innovation ecosystems is supported by the interviewees. According to INT20, "trust is a fundamental basis for things to work well" in the ecosystem. Steinbruch et al. (2021) corroborate this perception by stating that trust is a critical condition

for collaboration and development of innovation ecosystems. Trust between actors is one of the main requirements, as it helps to reduce transactional uncertainty and creates opportunities for the exchange of goods and services that are difficult to price or contractually impose. Furthermore, given its socially complex and idiosyncratic character to each relationship (Dyer & Singh, 1998), it also increases the access to resources and strengthens the capacity of actors to adapt to unforeseen problems (Uzzi, 1996).

However, in the innovation ecosystem of Porto Alegre, distrust was especially highlighted. According to INT5, there is still little trust between actors in the ecosystem, especially because they don't know exactly what is the role they should perform and how one actor complements another. INT5 says that:

> *In Porto Alegre, the actors still do not have sufficient financial and revenue scale to survive and each one is doing a little bit of everything and generates a process that is not yet qualified [...] so this, in my opinion, does not generate trust necessary for the system to function more organically because if you are constantly fighting for survival, you view everyone else in the ecosystem as a partner, but more essentially as an adversary. If there was already a clear maturation process for each one's role, everyone would have more peace of mind to orchestrate more complex processes.*

Therefore, network orchestration in the innovation ecosystem of Porto Alegre should create more opportunities to trust building between its actors as the atmosphere of trust in an innovation ecosystem should lead its actors to a greater exchange of information and solutions to problem situations, as decision makers tend to feel more protected from opportunistic behaviors (Jarillo, 1988). In ecosystems like the Porto Alegre's one, where distrust is high and the tendency of actors to behave in an opportunistic manner is also higher, building trust is even more important (Ghio, Gherini, and Rossi-Lamastra, 2019).

Another subprocess of appropriation of innovation is procedural justice. Procedural justice cares about the fairness of the decision process (Kim and Mauborgne, 1998). In the innovation ecosystem, the deliberative instance of the "Mesa" of Pacto Alegre was cited by the interviewees as a mechanism that guarantees bilateral communication between actors and provides consistency in the decision-making process and adequate accountability of these decisions, characteristics necessary for this subprocess (Dhanaraj and Parkhe, 2006), as the Pacto Alegre is the main hub of orchestration of the Porto Alegre ecosystem.

Finally, the appropriation of innovation also depends on resources jointly taken by the actors. The collaborative projects of Pacto Alegre can be cited as examples of this type of strategy. Two of them, in particular, were cited by several interviewees and consist of assets jointly owned by more than one actor: the MBA course in Innovation Ecosystems offered by

the Alliance for Innovation, in a partnership between the three largest universities in the ecosystem, and the Caldeira Institute, a physical innovation hub that connects the quadruple helix actors in Porto Alegre and brings together more than 40 founders of the four groups of the helix. According to INT3 "has an absolutely strategic role [...] of making the transition from the 19th century competition paradigm to the 21st century paradigm which is a paradigm of cooperation." Joint ownership of assets is critical for the appropriation of innovation, since it creates mutual responsibility, an opportunity for joint problem solving and increases the commitment of actors to shared objectives (Dhanaraj & Parkhe, 2006).

Regarding the network stability and its first subprocess, enhance reputation, innovation ecosystems are characterized by loose coupling between the networked actors (Iansiti and Levien, 2004; Shipilov and Gawer, 2020), the reputation and legitimacy of the orchestrators are strengthened so that the other actors do not demobilize and wish to leave the network. In this case, again the role of Pacto Alegre stands out in the innovation ecosystem of Porto Alegre. It can be inferred from the interviewees' testimony that Pacto Alegre is, at the same time, the orchestrator of the ecosystem and its main element of cohesion, and as its legitimacy strengthens the more actors tend to engage in collaborative projects and seek belonging to the network.

Expectations of future earnings are also one of the points to increase network stability through the subprocess “lengthen the shadow of the future" (Dhanaraj and Parkhe, 2006). In the innovation ecosystem of Porto Alegre, the effective results achieved by the projects are motivating for the actions and engagement of the actors. In addition, when there is clarity in the roles of each participant and there are expectations of future gains, the actors tend to commit more. The Caldeira Institute is. Caldeira was the first project of Pacto Alegre (Gauchazh, 2021), and and has influenced the emergence of other initiatives in the geographic area where it is located, in Porto Alegre (Jornal do Comércio, 2022), and in other innovation hubs that are being built in the interior of Rio Grande do Sul (GAZ, 2021).

Actors also cooperate in order to overcome global challenges and compete internationally. Thus, the ecosystem’s relational resources make them stronger, especially in the IT sector, which has seen a rapid increase in demand due to the Covid-19 pandemic. Therefore, projects such as +PraTI, which combines resources of private companies in order to finance scholarships for training young people in the IT area, serve local companies in a scenario of global competition, contributing to the development of the ecosystem. On the other hand, the opportunity cost of these professionals increases, who are now in demand by

companies abroad. Thus, a well-developed innovation ecosystem, with good opportunities and quality of life is even more necessary to keep these talents.

5.2 Orchestration of Relational Resources

In the first dimension of resources, there was a consensus among interviewees that intellectual capital is one of the main relational resources in Porto Alegre, which stand out in relation to other ecosystems, due to the existence of universities of excellence and formation of qualified human capital. More than that, the key role of the Pacto Alegre and the Aliança para a Inovação, an institutionalized movement of the three leading universities for innovation, in leading development and playing a central role in orchestrating the ecosystem was emphasized. In addition, other movements, such as Porto Alegre Inquieta, were highlighted by the interviewees. Thus, intellectual capital and collaborative movements can be inferred as strategic relational resources of Porto Alegre

Interviewees also highlighted the existence of prominent environments in the innovation ecosystem of Porto Alegre, especially the three science and technology parks linked to universities of excellence. This type of environment allows, among other things, the transfer of technology from academia to the market and the emergence of academic spinoffs. These spinoffs, when conceived as relational resources, resulting from the combination of academic knowledge, with capable entrepreneurs and investors' financial capital, for example, make it possible to take the frontier knowledge developed in universities for the market, also contributing to the ecosystem to become more robust with innovative technologies (Pattnaik and Pandey, 2014). However, despite its existence in the ecosystem, an important relational resource that respondents argue is not available in sufficient volume is the financial capital needed to invest in innovation.

The existence of relational resources that are valuable, rare, and inimitable, the organization to use them – VRIO (Barney, 1995) in the ecosystem depends on orchestration. Hence, ecosystem’s relational resources already structured and bundled should be leveraged. In the innovation ecosystem of Porto Alegre, the mobilization of resources occurs through the identification of what are the complementarities among actors. After, there is a reunion of these resources in events such as workshops, meetings, and the building of relational resources through the complementary resources that each player makes available to the ecosystem.

After the mobilization of the resources, their coordination is the following subprocess. Coordination involves integrating resources to configure new capabilities. In addition, relational skills evolve from the reinforcement of trust (Sirmon et al., 2011). According to INT2, the Porto Alegre ecosystem has always had good resources, including stronger resources than other innovation ecosystems that are reference in Brasil, Latin America, and global, such as Recife, Medellin, Colombia, and Barcelona, respectively. According to him, however, there was always a gap in the ecosystem to transform them into strategic relational resources. INT16 supports this argument and points out that "what I see is an inability to articulate these resources". Thus, the role of the orchestrator is essential, which, in this case, is played by Pacto Alegre, according to INT2 "Pacto as one of the great connection platforms."

Finally, the leverage process has a last subprocess called deployment. Deployment involves the creation of value through the successful utilization of resources (Sirmon et al., 2011). Considering the Pacto Alegre as the main orchestrator of the innovation ecosystem of Porto Alegre, the resource leverage strategy used includes, first, the use of resources already existing in the ecosystem, through an effectuation strategy (Sarasvathy, 2001). INT2 argues that: "we had to start with the resources we already had. Start the pact [...] by articulating the available resources".

INT17 points to creativity as a necessary resource for the creation of relational resources and the use of these successfully. This interviewee exemplifies the successful deployment of relational resources, created from the use of complementary resources of ecosystem actors, through the Go.Globalx project, which involved the participation of three scientific and technological parks linked to universities, civil society organization and development bank with the purpose of fostering new innovative businesses.

6. Conclusion

This paper aimed to analyze the orchestration of actors and relational resources in innovation ecosystems. For that purpose, we identified the innovation network orchestration strategies employed by the actors of the innovation ecosystem of Porto Alegre, in Brazil, as well as the relational resources and its resource orchestration strategies used by the actors to drive the development of the ecosystem. We found that especially trust influences in the orchestration of actors. Moreover, guaranteeing the exchange and equanimous appropriability

of knowledge, as well as a common identity among actors, and the expected earnings influence their orchestration.

On the relational resources' orchestration, we found that the innovation ecosystem of Porto Alegre has idiosyncratic resources, but they were not being adequately exploited until the creation of the Aliança para a Inovação and the Pacto Alegre. The first one can be seen itself as a relational resource and the second is the main orchestrator of the ecosystem. The Pacto Alegre is the collective movement for innovation that nowadays has both the responsibility and the capacity to leverage the relational resources of the ecosystem, such as the collective movements, connections, collaborative projects, and especially the intellectual capital.

We conclude that orchestration is an effective strategy for the management of innovation ecosystems, especially when the IE is at intermediate evolution stages and needs to mature the relationships between actors and leverage its relational resources. As theoretical contributions, this paper highlights the importance of relational resources in ecosystems, especially their leverage, explores the role of actor orchestration and relational resources for the development of innovation ecosystems and validates a framework for the analysis of different ecosystems. For practitioners, the main empirical contributions are in the scope of identifying a method for the orchestration of ecosystems, as well as providing insights for the elaboration of policies and strategies aimed at the development of innovation ecosystems at the territorial level - in cities or regions.

However, given the dynamics of the ecosystems and its dynamic nature, new possibilities should be exploited, as the coordination strategy of an innovation ecosystem depends on its unique characteristics (Scaringella & Radziwon, 2018) and evolutionary stage. Therefore, the needs of an ecosystem change over time as the ecosystem evolves and the coordination strategies of these ecosystems must also evolve (Rietveld & Schilling, 2020). throughout its life cycle. We suggest a new investigation dealing with coordination and ecosystem life cycle. We also suggest a quantitative study, measuring the processes and subprocesses resulting from the orchestration of networks and relational resources. Such research can lead to a more objective understanding of how ecosystem orchestration occurs.

As limitations, we highlight the fact that not all subgroups of actors belonging to the quadruple helix were interviewed, such as representatives of large companies, investors, influencers, among others. Furthermore, given that each innovation ecosystem is unique and has its own idiosyncrasies, it is necessary to research other innovation ecosystems at the city level to validate the propositions presented in this paper.

References

Aliança para Inovação (2021). Retrieved from: https://alianca.pucrs.br/

Autio, E., & Thomas, L. (2014). Innovation Ecosystems: Implications for Innovation Management? in Dodgson, M., Gann, D. M., & Phillips, N. (Eds.). *The Oxford handbook of innovation management*. Oxford University Press, Oxford, pp. 204-288.

Bardin, L. (1977). *Análise de Conteúdo*. Martins Fontes.

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of management*, *17*(1), 99-120. Retrieved from: https://journals.sagepub.com/doi/10.1177/014920639101700108 https://doi.org/10.1177/014920639101700108

Borgatti, S. P., & Foster, P. C. (2003). The network paradigm in organizational research: A review and typology. *Journal of Management*, *29*(6), 991-1013. Retrieved from: https://www.sciencedirect.com/science/article/abs/pii/S0149206303000874?via%3Dihub https://doi.org/10.1016/S0149-2063(03)00087-4

Camisón, C., & Forés, B. (2010). Knowledge absorptive capacity: New insights for its conceptualization and measurement. *Journal of Business Research*, *63*(7), 707-715.

Carayannis, E. G., & Campbell, D. F. (2009). 'Mode 3' and 'Quadruple Helix': toward a 21st century fractal innovation ecosystem. International Journal of Technology Management, Vol. 46 No. 3-4, pp. 201-234.

Carayannis, E. G., Grigoroudis, E., Campbell, D. F. J., Meissner, D. & Stamati, D. (2018), The ecosystem as helix: an exploratory theory-building study of regional co-opetitive entrepreneurial ecosystems as Quadruple/Quintuple Helix Innovation Models. *R&D Management*, 48, 148-162. Retrieved from: https://onlinelibrary.wiley.com/doi/abs/10.1111/radm.12300 https://doi.org/10.1111/radm.12300

Cavallini, S., Soldi, R., Friedl, J., & Volpe, M. (2016). Using the quadruple helix approach to accelerate the transfer of research and innovation results to regional growth. *Consortium Progress Consulting Srl & Fondazione FoRmit*. Retrieved from: https://op.europa.eu/en/publication-detail/-/publication/6e54c161-36a9-11e6-a825-01aa75ed71a1

Cennamo, C., & Santaló, J. (2019). Generativity tension and value creation in platform ecosystems. Organization Science, 30(3), 617-641.

Chesbrough, H. W. (2003). *Open innovation: The new imperative for creating and profiting from technology*. Harvard Business Press.

Creswell, J. W. (2014). *Investigação Qualitativa e Projeto de Pesquisa-: Escolhendo entre Cinco Abordagens*. Penso Editora.

Dhanaraj, C., & Parkhe, A. (2006). Orchestrating innovation networks. *Academy of Management Review*, *31*(3), 659-669. Retrieved from: https://journals.aom.org/doi/10.5465/amr.2006.21318923 https://doi.org/10.5465/amr.2006.21318923

Dyer, J. H., & Singh, H. (1998). The relational view: Cooperative strategy and sources of interorganizational competitive advantage. *Academy of Management Review*, *23*(4), 660-679.

Retrieved from: https://journals.aom.org/doi/10.5465/amr.1998.1255632 https://doi.org/10.5465/amr.1998.1255632

Dyer, J. H., Singh, H., & Hesterly, W. S. (2018). The relational view revisited: A dynamic perspective on value creation and value capture. *Strategic Management Journal*, *39*(12), 3140-3162. Retrieved from: https://onlinelibrary.wiley.com/doi/abs/10.1002/smj.2785 https://doi.org/10.1002/smj.2785

Endeavor & Enap (2020). Índice de cidades empreendedoras. Endeavor Brasil. Retrieved from https://repositorio.enap.gov.br/bitstream/1/6097/1/relatorio_ICE_2020.pdf

Etzkowitz, H., & Leydesdorff, L. (1995). The Triple Helix - University-industry-government relations: A laboratory for knowledge based economic development. *EASST review*, *14*(1), 14-19. Retrieved from: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2480085

Etzkowitz, H., & Leydesdorff, L. (2000). The dynamics of innovation: from National Systems and "Mode 2" to a Triple Helix of university–industry–government relations. *Research Policy*, *29*(2), 109-123. Retrieved from: https://www.sciencedirect.com/science/article/abs/pii/S0048733399000554?via%3Dihub https://doi.org/10.1016/S0048-7333(99)00055-4

Fernandes, C.C., Oliveira Jr., M.d.M., Sbragia, R., and Borini, F.M. (2017), "Strategic assets in technology-based incubators in Brazil". *European Journal of Innovation Management*, *20*(1), 153-170. Retrieved from: https://www.emerald.com/insight/content/doi/10.1108/EJIM-04-2016-0043/full/html. https://doi.org/10.1108/EJIM-04-2016-0043

Fernandes, C.C., Oliveira Jr., M.d.M., Sbragia, R., and Borini, F.M. (2017), "Strategic assets in technology-based incubators in Brazil". *European Journal of Innovation Management*, *20*(1), 153-170. Retrieved from: https://www.emerald.com/insight/content/doi/10.1108/EJIM-04-2016-0043/full/html. https://doi.org/10.1108/EJIM-04-2016-0043

GAZ (2021). Comitiva de Santa Cruz faz visita à Capital e projeta implantação de Berçário Tecnológico. Retrieved from: https://www.gaz.com.br/comitiva-de-santa-cruz-faz-visita-a-capital-e-projeta-implantacao-de-bercario-tecnologico/

Gauchazh (2022). Marca de POA dá mais motivos para acreditar nos próximos 250 anos. Retrieved from: https://gauchazh.clicrbs.com.br/porto-alegre/noticia/2022/02/marca-de-poa-da-mais-motivos-para-acreditar-nos-proximos-250-anos-ckzzh7g29000p017cbkqhoa6c.html

Ghio, N., Guerini, M. & Rossi-Lamastra, C. (2019) The creation of high-tech ventures in entrepreneurial ecosystems: exploring the interactions among university knowledge, cooperative banks, and individual attitudes. *Small Business Economics* 52, 523–543. Retrieved from: https://link.springer.com/article/10.1007/s11187-017-9958-3 https://doi.org/10.1007/s11187-017-9958-3

Gil, A. C. (2002). Como elaborar projetos de pesquisa. São Paulo: Atlas.

Gomes, L. A. V., Chaparro, X. A. F., Facin, A. F. F., & Borini, F. M. (2021). Ecosystem management: Past achievements and future promises. *Technological Forecasting and Social Change*, *171*, 120950. https://doi.org/10.1016/j.techfore.2021.120950

Governo do Estado do Rio Grande do Sul (2021). Conheça o Inova RS. Retrieved from: https://www.inova.rs.gov.br/conheca-inova-rs

Gulati, R. (1998). Alliances and networks. *Strategic Management Journal*, *19*(4), 293-317. Retrieved from: https://onlinelibrary.wiley.com/doi/10.1002/(SICI)1097-0266(199804)19:4%3C293::AID-SMJ982%3E3.0.CO;2-M

https://doi.org/10.1002/(SICI)1097-0266(199804)19:4<293::AID-SMJ982>3.0.CO;2-M

Hair, J., Babin, B., Money, A., & Samouel, P. (2005). *Fundamentos de métodos de pesquisa em administração*. Bookman Companhia Ed.

Hitt, M. A., Ireland, R. D., & Hoskisson, R. E. (2017). *Strategic management: Concepts and cases: Competitiveness and globalization*. Cengage Learning.

Iansiti, M., & Levien, R. (2004). Strategy as ecology. *Harvard Business Review*, *82*(3), 68-78.

IBGE – INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA (2019). Cidades: Porto Alegre. Retrieved at https://cidades.ibge.gov.br/brasil/rs/portoalegre/panorama

Isenberg, D.J. (2010). How to start an entrepreneurial revolution. *Harvard Business Review*, 88(6), 40-50.

Jarillo, J. C. (1988). On strategic networks. *Strategic Management Journal*, *9*(1), 31-41. Retrieved from: https://onlinelibrary.wiley.com/doi/abs/10.1002/smj.4250090104 https://doi.org/10.1002/smj.4250090104

Jornal do Comércio (2022). *Mercado Paralelo acelera retomada do 4º Distrito*. Retrieved from: https://www.jornaldocomercio.com/_conteudo/ge2/noticias/2022/02/832179-mercado-paralelo-acelera-retomada-do-4-distrito.html

Karlsen, J., Larrea, M. (2016). Territorial Development and Action Research: Innovation Through Dialogue. Routledge, United Kingdom.

Kraaijenbrink, J., Spender, J. C., & Groen, A. J. (2010). The resource-based view: a review and assessment of its critiques. *Journal of Management*, *36*(1), 349-372. Retrieved from: https://journals.sagepub.com/doi/10.1177/0149206309350775 https://doi.org/10.1177/0149206309350775

Lavie, D. (2006). The competitive advantage of interconnected firms: An extension of the resource-based view. *Academy of Management Review*, *31*(3), 638-658. Retrieved from: https://journals.aom.org/doi/10.5465/amr.2006.21318922. https://doi.org/10.5465/amr.2006.21318922

Martin, R., & Sunley, P. (2006). Path dependence and regional economic evolution. *Journal of economic geography*, *6*(4), 395-437.

Martins, B.V., Faccin, K., Motta, G.D.S., Bernardes, R., Balestrin, A. (2019). Evolução e tendências da agenda de pesquisa internacional em inovação. *Revista de Administração de Empresas*, 59(4), 293-307.

Mulas, Victor & Minges, Michael & Applebaum, Hallie. (2016). Boosting Tech Innovation: Ecosystems in Cities: A Framework for Growth and Sustainability of Urban Tech Innovation Ecosystems. *Innovations: Technology, Governance, Globalization*. 11. 98-125. 10.1162/inov_a_00251.

Oliveira Jr., Moacir de Miranda, Cahen, Fernanda Ribeiro; Borini, Felipe Mendes (2019). Introduction. In: Startups and Innovation Ecosystems in Emerging Markets. Palgrave Macmillan, Cham, 2019a.

Pfeffer, J., & Salancik, G. R. (2003). The external control of organizations: A resource dependence perspective. Stanford University Press.

Presutti, M., Boari, C., & Majocchi, A. (2013). Inter-organizational geographical proximity and local startups' knowledge acquisition: a contingency approach. *Entrepreneurship & Regional Development*, Vol. 25, No. 5-6, pp. 446-467.

Provan, K. G., Fish, A., & Sydow, J. (2007). Interorganizational networks at the network level: A review of the empirical literature on whole networks. *Journal of Management*, *33*(3), 479-516. Retrieved from: https://journals.sagepub.com/doi/10.1177/0149206307302554. https://doi.org/10.1177/0149206307302554

Rabelo, R. J., & Bernus, P. (2015). A holistic model of building innovation ecosystems. *IFAC-PapersOnLine*, *48*(3), 2250-2257. Retrieved from: https://www.sciencedirect.com/science/article/pii/S240589631500662X?via%3Dihub. https://doi.org/10.1016/j.ifacol.2015.06.423

Rietveld, J., & Schilling, M. A. (2021). Platform competition: A systematic and interdisciplinary review of the literature. *Journal of Management*, *47*(6), 1528-1563.

Sampieri, R. H., Collado, C. F., & Lucio, M. del P. B. (2013). Metodologia de Pesquisa. Porto Alegre: Penso.

Santos, D. A. G. dos, Zen, A. C., & Bittencourt, B. A. (2021). From governance to choreography: coordination of innovation ecosystems. *Innovation & Management Review*.

Santos, D. A. G. dos; Zen, A. C. (2020). Orquestração de Atores e Recursos em Ecossistemas de Inovação. In: XLIV Encontro da Anpad - EnANPAD 2020.

Santos, D. A. G. dos; Zen, A. C.; Faccin, K. (2020). Mapping, Analyzing, and Designing Innovation Ecosystems in Cities: an Action Research Approach. In: XXIII Seminários em Administração - Semead 2020. São Paulo.

Sarasvathy, S. D. (2001). Causation and effectuation: Toward a theoretical shift from economic inevitability to entrepreneurial contingency. *Academy of management Review*, *26*(2), 243-263.

Pattnaik, P. N., & Pandey, S. C. (2014). University spinoffs: what, why, and how?. *Technology Innovation Management Review*, *4*(12).

Scaringella, L., & Radziwon, A. (2018). Innovation, entrepreneurial, knowledge, and business ecosystems: Old wine in new bottles?. *Technological Forecasting and Social Change*, *136*, 59-87.

Schaeffer, P., Fischer, B., Queiroz, S.R., 2018. Innovation Ecosystems in Brazil: Research Universities as Drivers of Competitiveness. Paper presented at Simpósio de Gestão da Inovação Tecnológica 2018, Porto Alegre.

Shaw, D. R., & Allen, T. (2018). Studying innovation ecosystems using ecology theory. *Technological Forecasting and Social Change*, *136*, 88-102. Retrieved from: https://www.sciencedirect.com/science/article/abs/pii/S0040162516307880?via%3Dihub. https://doi.org/10.1016/j.techfore.2016.11.030

Shi, Q. and Shen, L. (2021), "Orchestration capability: a bibliometric analysis", *Kybernetes*, Vol. ahead-of-print No. ahead-of-print. https://doi.org/10.1108/K-05-2021-0386

Shipilov, A., & Gawer, A. (2020). Integrating research on interorganizational networks and ecosystems. *Academy of Management Annals*, *14*(1), 92-121. Retrieved from: https://journals.aom.org/doi/10.5465/annals.2018.0121. https://doi.org/10.5465/annals.2018.0121

Sirmon, D. G., Hitt, M. A., & Ireland, R. D. (2007). Managing firm resources in dynamic environments to create value: Looking inside the black box. *Academy of Management Review*, *32*(1), 273-292. Retrieved from:

https://journals.aom.org/doi/10.5465/amr.2007.23466005. https://doi.org/10.5465/amr.2007.23466005

Sirmon, D. G., Hitt, M. A., Ireland, R. D., & Gilbert, B. A. (2011). Resource orchestration to create competitive advantage: Breadth, depth, and life cycle effects. *Journal of Management*, *37*(5), 1390-1412. Retrieved from: https://journals.sagepub.com/doi/10.1177/0149206310385695. https://doi.org/10.1177/0149206310385695

Startup Base (2021). Estatísticas. Retrieved from: https://startupbase.com.br/home/stats

Steinbruch, F. K., da Silva Nascimento, L., & de Menezes, D. C. (2021). The role of trust in innovation ecosystems. *Journal of Business & Industrial Marketing*.

Suominen, A., Seppänen, M., Dedehayir, O. (2019). A bibliometric review on innovation systems and ecosystems: A research agenda. European Journal of Innovation Management 22(2), 335-360. Retrieved from: https://www.emerald.com/insight/content/doi/10.1108/EJIM-12-2017-0188/full/html. https://doi.org/10.1108/EJIM-12-2017-0188

Suominen, A., Seppänen, M., Dedehayir, O. (2019). A bibliometric review on innovation systems and ecosystems: A research agenda. European Journal of Innovation Management 22(2), 335-360. Retrieved from: https://www.emerald.com/insight/content/doi/10.1108/EJIM-12-2017-0188/full/html. https://doi.org/10.1108/EJIM-12-2017-0188

Thomas, L.D., Sharapov, D., Autio, E. (2018). Linking entrepreneurial and innovation ecosystems: The case of AppCampus. In Entrepreneurial ecosystems and the diffusion of startups. Edward Elgar Publishing, United Kingdom.

uMov.me (2021). Dito Efeito. Retrieved from: https://www.umov.me/category/dito-efeito/

UNIDO (2019). Bridge for Cities 4.0. Retrieved from: https://www.unido.org/sites/default/files/files/2019-09/Bridge4Cities%20Issue%20Paper_Final.pdf

Uzzi, B. (1996). The sources and consequences of embeddedness for the economic performance of organizations: The network effect. *American Sociological Review*, 674-698. Retrieved from: https://www.jstor.org/stable/2096399?origin=crossref&seq=1#metadata_info_tab_contents. https://doi.org/10.2307/2096399

Valkokari, K., Seppänen, M., Mäntylä, M., & Jylhä-Ollila, S. (2017). Orchestrating innovation ecosystems: A qualitative analysis of ecosystem positioning strategies. *Technology Innovation Management Review*, *7*(3). Retrieved from: https://timreview.ca/sites/default/files/article_PDF/Valkokari_et_al_TIMReview_March2017.pdf

Walrave, B., Talmar, M., Podoynitsyna, K. S., Romme, A. G. L., & Verbong, G. P. (2018). A multi-level perspective on innovation ecosystems for path-breaking innovation. *Technological Forecasting and Social Change*, *136*, 103-113. Retrieved from: https://www.sciencedirect.com/science/article/abs/pii/S0040162517304997?via%3Dihub. https://doi.org/10.1016/j.techfore.2017.04.011

World Bank (2020b). *Urban Development*: Overview. Retrieved from: https://www.worldbank.org/en/topic/urbandevelopment/overview#1

Yahoo (2022). *South Summit, um dos maiores eventos de inovação, chega pela 1ª vez ao Brasil*. Retrieved from: https://br.noticias.yahoo.com/south-summit-um-dos-maiores-141200457.html

Zen, A. C., Santos, D. A. G., Faccin, K., & Gonçalves, L. F. (2019). *Mapeamento do Ecossistema de Inovação: Percepções e Desafios*. Retrieved at: https://pactoalegre.poa.br/downloads

Zeng, J., Tavalaei, M. M., & Khan, Z. (2021). Sharing economy platform firms and their resource orchestration approaches. *Journal of Business Research*, *136*, 451-465.

Apendix A. Interview Script (Portuguese)

Perfil:

01 – IDENTIFICAÇÃO DO(A) ENTREVISTADO(A)

Nome:	
Entidade:	**Hélice:**
Cargo:	

Introdução: Nessa pesquisa, nós consideramos como ecossistema de inovação de Porto Alegre a rede de atores (organizações públicas e privadas) que atuam para gerar a inovação na cidade, bem como os recursos que são desenvolvidos por essa rede.

1) Você poderia me contar um pouco sobre sua participação e a de sua organização no desenvolvimento do ecossistema de inovação de Porto Alegre? *Quando iniciou a sua atuação? Quais as principais atividades ou projetos que você realizou para o desenvolvimento do ecossistema?*

2) A sua organização está envolvida em projetos colaborativos para o desenvolvimento do ecossistema de inovação de Porto Alegre? Quais?
3) *Na sua opinião,* quais foram as razões que levaram a sua organização a participar de projetos com outros atores do ecossistema de inovação de Porto Alegre?
4) Como você considera que sua organização pode ajudar no desenvolvimento do ecossistema de inovação de Porto Alegre?

Recursos Relacionais: Pensando na cidade de Porto Alegre como um ecossistema de inovação, essa rede de atores gera um conjunto de recursos compartilhados. Esses recursos são organizados em seis grupos: Capital Intelectual (qualificação do capital humano e disponibilização do conhecimento produzido no ambiente universitário), Capital Financeiro (financiamento de negócios e projetos inovadores), Capital Estrutural (infraestrutura para a inovação), Capital Institucional (leis, normas, regulações e cultura) e Capital Social (redes, interação e qualidade de vida):

5) Quais são os principais recursos que a sua organização aporta para o desenvolvimento do ecossistema de inovação de Porto Alegre?
6) Quais são os recursos necessários para potencializar a inovação na cidade de Porto Alegre?
7) Quais recursos você considera serem estratégicos para o desenvolvimento da cidade de Porto Alegre por meio da inovação?
8) Em relação aos recursos relacionais da cidade de Porto Alegre, quais você considera que geram uma vantagem em relação a outros ecossistemas?

9) Dentre esses recursos compartilhados e gerados a partir da interação dos atores do ecossistema, quais você considera:

Recursos Relacionais de Porto Alegre	Valioso (é muito importante para as empresas e a sociedade)	Raro (não é fácil de encontrar em outros ecossistemas)	Difíceis de imitar (outras cidades não conseguiriam copiar facilmente)	Explorado na estratégia coletiva da cidade

Orquestração dos atores da quádrupla hélice (governo, empresas, universidades e sociedade civil – ONGs, Coletivos, Associações de Bairro, Movimentos Informais com objetivos definidos, etc)

10) Na sua opinião, como ocorre o alinhamento entre os interesses individuais de cada um dos atores e coletivos para o desenvolvimento do ecossistema de inovação de Porto Alegre? Confiança para o alinhamento dos interesses
11) Em sua percepção, quais são os principais resultados que podem ser obtidos ao ocorrer o alinhamento de interesses individuais e coletivos na construção de um ecossistema de inovação mais desenvolvido? Os ecossistemas que prosperam são aqueles nos quais os atores mais colaboram.
12) Em sua percepção, quais são os principais desafios para alinhar os interesses individuais e coletivos na construção de um ecossistema de inovação mais desenvolvido? Pensar formas de evoluir os sistemas de colaboração.
13) De que forma sua organização busca e troca conhecimentos para o desenvolvimento do ecossistema?
14) Em sua percepção, existem incentivos para a interação e trocas de conhecimento frequentes entre os atores da quádrupla hélice do ecossistema de inovação de Porto Alegre? Se sim, quais?
15) Como ocorre a mobilização de recursos pelos atores da quádrupla hélice para o desenvolvimento do ecossistema de inovação de Porto Alegre?
16) Em sua percepção, de que forma os recursos mobilizados pelos atores da quádrupla hélice são coordenados para o desenvolvimento do ecossistema?
17) De que forma os recursos compartilhados pelos atores da quádrupla hélice são implementados para o desenvolvimento do ecossistema?
18) Qual sua percepção sobre o papel dos mecanismos de gestão do relacionamento entre os atores no desenvolvimento do ecossistema de inovação de Porto Alegre?

Resultados e Desafios

19) Qual é a sua avaliação em relação aos resultados alcançados para o desenvolvimento do ecossistema de inovação de Porto Alegre até 2021?
20) Quais foram os principais ganhos e quais são os principais desafios ainda a enfrentar?
Como o ecossistema de inovação de Porto Alegre se organizou para enfrentar a pandemia de COVID-19?

5. PAPER IV:

From Governance to Choreography:

Coordination of Innovation Ecosystems[5]

[5] Paper published in the journal Innovation and Management Review.
Santos, D. A. G. dos, Zen, A. C., & Bittencourt, B. A. (2021). From governance to choreography: coordination of innovation ecosystems. Innovation & Management Review.

ABSTRACT:

Purpose: Innovation ecosystems can emerge and grow organically, but the process can also be managed through conscious intervention. Therefore, we can observe different motivations and expectations for each group of actors. The lack of alignment between actors could have a negative influence on the development of innovation ecosystems. This paper aims to analyze the coordination strategies of the actors throughout the life cycle of innovation ecosystems. **Design/methodology/approach:** This is a theoretical essay in which we develop and propose a model for coordinating innovation ecosystems based on the theoretical backgrounds of the Ecosystem Life Cycle, and Ecosystem Coordination. **Findings:** We argue that each stage of an innovation ecosystem's life cycle - inception, launching, growth, and maturity - demands different coordination strategies. Initially, networks are simpler and thus the coordination issues are less difficult. However, as the ecosystem evolves and the complexity of the networks increases, a more sophisticated strategy, such as orchestration or choreography, is needed. **Research limitations/implications:** This is a theoretical paper, and we recommend further research to test our model. **Practical implications:** The understanding of coordination and stages of the life cycle of an innovation ecosystem can guide actors in the design of strategies for the development of ecosystems. **Social implications:** The proposed framework could support strategies to engage civil society in actions to develop innovation ecosystems. **Originality/value:** We present a framework to understand the coordination strategies better, considering the stages of an innovation ecosystem's life cycle.

Keywords: Innovation Ecosystem; Ecosystem Life Cycle; Ecosystem Coordination

1. Introduction

Fostering innovation ecosystems is an increasingly adopted strategy by governments around the world to promote socioeconomic development, from Massachussets (Reynolds and Uygun, 2018) and the Silicon Valley (Piqué, Berbegal-Mirabent, and Etzkowitz, 2018), in the United States, to Barcelona, Spain (Piqué, Miralles, and Berbegal-Mirabent, 2019), and Porto Alegre, Brazil (Zen, Santos, Faccin, and Gonçalves, 2019). Many policymakers have noticed that a city or a region often invests a lot of resources in qualifying human capital. Still, suppose it does not provide opportunities nor the necessary conditions for these talents to work and have a good quality of life. In that case, they usually migrate to other localities and thus stop contributing for the development of the place where they were born or trained (Dirks, Gurgdiev and Keeling, 2010; Betz, Partridge and Fallah, 2016; European Union, 2016). In order to retain these talents and promote development, innovation ecosystems have been seen as a holistic solution to have a vibrant city, which generates opportunities continuously and is invigorated at all times to offer a high quality of life to its citizens.

At the city level, an innovation ecosystem can be defined as a set of interdependent actors with conflicting technical, social, economic, and political interests, but also converging goals, priorities, expectations, and behaviors that cooperate and compete concomitantly in a specific geographical location. Thus, innovation ecosystems are hybrids of different networks and systems with fractal, multilevel, multimodal, multinodular, and multilateral configurations, with tangible and intangible dynamic assets designed to promote innovation in a territory (Carayannis, Grigoroudis, Campbell, Meissner, and Stamati, 2018).

The innovation ecosystems can emerge and grow organically; however, the process can also be managed through conscious intervention. In this way, Heaton, Siegel and Teece (2019) argue that the resources must be orchestrated by a strong player willing to take the lead, especially in the city context, where each group of actors usually have different motivations and expectations. The lack of alignment between actors could negatively influence the development of innovation ecosystems (Bittencourt, Zen, Schmidt, and Wegner, 2018).

On the other hand, due to their evolutionary nature, innovation ecosystems develop and change over time, according to life cycle stages. However, despite the importance of understanding how the dynamics of innovation ecosystems work, the concept of life cycle is undertheorized in this field (Rabelo and Bernus, 2015; Piqué et al., 2019; Cantner, Cunningham, Lehmann, and Menter, 2020). Each stage of a life cycle presents distinct characteristics and

behaviors from actors. Thus, these idiosyncratic configurations demand different coordination strategies to mobilize the actors, align the interests and create a common agenda.

This paper aims to analyze the coordination strategies used for the actors' alignment throughout the life cycle of innovation ecosystems. We argue that each stage of the life cycle of an innovation ecosystem demands different coordination strategies. As an interdependent network of actors, this coordination can be more formal, in which we can easily identify the leader and agenda. However, when the network has stability and complexity, ecosystem coordination can be more informal or even diffuse among actors.

We identified a gap in the literature about this dynamic of the ecosystem's life cycle and the coordination strategies in each stage. The literature in innovation ecosystems presents a substantial growth in the last decade (Suominen, Seppänen, and Dedehayir, 2019), yet few authors explore the life cycle of the innovation ecosystem (Piqué et al., 2019) and even the dynamic roles for actors to lead the ecosystem (Heaton, Siegel and Teece, 2019; Bittencourt, Zen, and Santos, 2020). Moreover, each life cycle stage has its idiosyncrasies and thus calls for a distinct coordination strategy.

As a theoretical contribution, we propose a reflection about actors' coordination strategies in an innovation ecosystem. Based on the life cycle models in inter-organizational arrangements, we argue that the inception stage demands a more centralized and formal strategy to align actors' motivation and activities. Otherwise, in the maturity stage, when the actors build trust, this coordination could be more decentralized and informal. Hence, we also present a framework to understand the coordination strategies better, considering the stages of an innovation ecosystem's life cycle.

This paper is structured as follows. Next section we present the theoretical background on the Geographically Bounded Innovation Ecosystem and its Life Cycle. In section three, we explain the Actors' Coordination Strategies. In the fourth section, we propose a Framework of Actors' Coordination in the Life Cycle of Innovation Ecosystems. Finally, in the last section, we draw contributions, implications and suggest further research.

2. Geographically Bounded Innovation Ecosystem and its Life Cycle

In geographically bounded innovation ecosystems, i.e., a city or a region, agglomeration can provide benefits such as knowledge spillovers and ease access to resources (Cantner et al., 2020). Co-location effects leverage the transfer of tacit knowledge (Presutti, Boari, and

Majocchi, 2013). The physical proximity between actors also helps them engage in partnerships to access complementary resources in the environment or with other actors, share resources, and build relational resources (Dyer, Singh, and Hesterly, 2018).

Therefore, at the same time actors compete for scarce resources, they must also cooperate to achieve competitive advantage. We consider that the actors in an innovation ecosystem can be grouped according to the quadruple helix model (Carayannis and Campbell, 2009). The quadruple helix model emphasizes the importance of interaction between academia, companies, government, and civil society so that processes of creation, diffusion, and application of new knowledge take place, which can result in new technologies and, ultimately, through the capture and delivery of economic and social value, territorial development (Cavallini, Soldi, Friedl, and Volpe, 2016; Carayannis et al., 2018).

The Academia group is composed by institutions that contribute to the ecosystem mainly through the qualification of human capital, production, and dissemination of knowledge, such as universities and other institutions of higher education and research. The Companies group includes startups, large companies, science and technology parks, business incubators and accelerators, angel and risk investors, and commercial banks. The actors engaged in transforming knowledge into new products and solutions. In turn, the Government group of actors is responsible for the institutional conditions that influence and guide the ecosystem; these actors are the government agencies, regulatory agencies, and public development banks. Finally, Civil society encompasses all individuals and organizations that benefit from innovation and help to achieve it, such as professionals from the creative class, first users, professionals supporting innovation and entrepreneurship, famous icons, opinion makers, experienced entrepreneurs, family, and friends.

The inclusion of civil society allows a "bottom-up" approach. Thus, the quadruple helix model maintains the interaction between the actors of the triple helix - academia, companies, and government - and formalizes society's participation in the innovation process to foster locoregional socio-economic development. Such a perspective allows territories to follow non-traditional innovation paths, including creating services, exploring creativity, non-technological improvements, and open innovation (Cavallini et al., 2016).

The inclusion of civil society among the actors is especially relevant in innovation ecosystems since citizens' needs are better understood and evaluated in this way. In a context of increasing complexity, in which characteristics such as transdisciplinarity and hybridization of knowledge become essential for the innovation process, the public interest must be

considered to discover and generate innovations that will promote social welfare (Yawson, 2009). With the fourth group of actors in the helix, innovation expands its technological focus and becomes a tool for overcoming urban challenges through sustainable transformations (Borkowska and Osborne, 2018).

In this paper, individual users are considered members of civil society, such as customers, citizens, or community members, who interact with academia, the government, and companies. These members use, benefit and help to achieve innovations that may contribute to their well-being and the socioeconomic development of the territory. Therefore, civil society requires active participation in the innovation process, contributing with its knowledge, inventiveness, and creativity, and providing constant feedback so that the solutions generated are appropriate to its needs (Cavallini et al., 2016). The quadruple helix model assumes that society demands innovation in goods and services and becomes an active part of the innovation process (Etzkowitz and Leydersdorff, 2000). An innovation ecosystem's effective coordination is needed to assure the participation and balance among the quadruple helix actors. Digitalization and Information and Communication Technologies can help in this process (Cavallini et al., 2016). The quadruple helix has an explicit focus on the dynamically interwoven coopetition processes, coevolution of different types of knowledge, and co-expertise, in the context of territorial innovation ecosystems (Carayannis et al., 2018). For this coordination to work appropriately, there is a need to understand in which stage of its life cycle the ecosystem is.

2.1 Life cycle of Innovation Ecosystems

The concept of life cycle of innovation ecosystems can be understood to be analogous to the biological systems in which the species born, develop, and die. However, the stream of research in innovation ecosystems has modestly explored the theme of life cycle (e.g. Rabelo and Bernus, 2015; Piqué et al., 2019). Therefore, to search for models dealing with the stages of the ecosystem life cycle, we considered the connection of this theme with the field of studies on geographic agglomerations (Spigel and Harrison, 2018), such as clusters (Menzel and Fornahl, 2010), entrepreneurial ecosystems (Cantner et al., 2020), and business ecosystems (Moore, 1993).

Within the cluster approach, the study of Menzel and Fornahl (2010) is one of the references in the cluster life cycle topic. These authors argue that clusters emerge, grow, sustain and decline. According to this model, what drives the cluster's evolution is the diversity and

heterogeneity of knowledge within it. Therefore, if the cluster can incorporate and exploit new knowledge, it evolves to a new stage of growth; however, if it fails, the cluster loses its competitive advantage and becomes imprisoned, thus achieving a stage of technological exhaustion.

In the ecosystem literature, Moore (1993) already pointed that ecosystems have development stages. These stages would be: birth, expansion, leadership, and self-renewal or death. In the birth phase, there is a shared understanding among the actors on what are the common objectives, thus assuring the collaboration among them and the delivery of value. In the expansion stage, the relationships between the actors are strengthened, and the ecosystem grows. The growing ecosystem starts to be competitive and to compete against other ecosystems. In the leadership phase, the ecosystem is a leader in one or more features, being more stable and richer in networks and generating value. As the competitiveness and complexity grow, the issues related to the coordination of the ecosystem improve simultaneously. The final stage is self-renewal or death. The ecosystem must explore new knowledge to invigorate or be terminated due to not being competitive anymore.

Cantner et al. (2020), in their dynamic life cycle model for entrepreneurial ecosystems, propose that the life cycle of ecosystems can explain how they arise and evolve. The authors propose a model consisting of five sequential phases: birth, growth, maturity, decline, and re-emergence. The event that characterizes the birth phase is an idea, referring to the recombination that leads to innovation, i.e. a new arrangement of existing resources to generate value for the quadruple helix actors. In the growth phase, actors become more specialized and start to employ and combine resources to develop the ecosystem. Also, in this phase the culture will be more favorable to entrepreneurship and innovation. The maturity stage is achieved when there is a stabilization of entrepreneurial and innovative activities and fewer incentives to entrepreneurship and innovation because the opportunity costs are higher. There is fewer entrepreneurial activity in the decline phase, and the ecosystem gets imprisoned in a specific technological regime; therefore, radical innovations are less likely to happen. This also makes the ideal scenario for new opportunities and for the re-emergence of the ecosystem. Finally, in the re-emergence phase, the entrepreneurial activity is resumed and there is space for the exploitation of new technological opportunities (Cantner et al., 2020).

There are also models describing the life cycle of a regional innovation ecosystem (eg. Rabelo and Bernus, 2015) or an innovation ecosystem of a specific district (e.g. Piqué et al., 2019). Rabelo and Bernus (2015) argue that the phases of the life cycle of an innovation

ecosystem are "Analysis", in which the decision to create the ecosystem is made; "Project" when the architecture of the ecosystem is defined; "Deployment", through the recruitment of key actors, the dissemination and establishment of formal and infrastructure conditions for the ecosystem to operate; "Execution", with ecosystem management activities; "Conclusion", in which the ecosystem goes through a metamorphosis to survive and continue to develop or is decommissioned; and last, "Sustenance", which is responsible for the future evolution and viability of the ecosystem.

According to Piqué et al. (2019), a specific district's innovation ecosystem evolves through four stages: inception, launching, growth, and maturity. The inception phase starts when there is a need to create an urban innovation ecosystem where talent, knowledge, and capital can exist and be exploited. After a strategy for creating the innovation ecosystem, it must have the necessary infrastructure to work, and actors must be attracted and articulated to understand their roles. The next stage is growth. The ecosystem already has an initial structure and starts to be more competitive, thus stimulating new businesses and giving rise to governance challenges. Finally, in the maturity stage, the ecosystem expands its internationalization and its leadership position; hence, its networks and resources call for orchestration to be internationally competitive and exploit new opportunities.

We add to these models the idea that the ecosystem does not necessarily go to the following phases for each phase. Given the complexities, dynamics, and natural conflicts existing inside it between the actors, the ecosystem can recede to one of the precedent phases without having completed the entire roadmap of the life cycle model. Thus, we propose that for a true dynamic life cycle model, both the possibilities of going forward (evolution) or going backward (involution) must be considered.

Therefore, we consider that the ecosystem evolves through the stages proposed by Piqué et al. (2019): inception, launching, growth, and maturity. In the inception stage, actors and resources are spread and demobilized. Then a strategy is needed for the emergence of the ecosystem. After in the launching phase, the strategy starts to be executed, and both actors and resources start to be mobilized. In the stage of growth, there is an acceleration of the collaboration processes and joint involvement in the development of the ecosystem. When the innovation ecosystem becomes vibrant, and interactions begin to flow more organically, it reaches the maturity stage.

Depending on the maturity of the ecosystem, there is a chance of existing a group of actors that get access to resources but don't contribute with their own resources. Thus

ecosystems must have an effective coordination strategy to mitigate this behavior and maintain a trustable environment where the other actors are still willing to collaborate and engage in joint actions. We propose that to assure collaboration among actors, innovation ecosystems can have formal or informal coordination mechanisms (Dyer and Hatch, 2006; Autio and Thomas, 2014), according to their stage of maturity or life cycle phase. A formal mechanism considers the existence of contracts, rules, and regulations. An informal mechanism depends on the norms of reciprocity and trust among actors, given they sustain the relationships among actors (Provan, Fish, and Sydow, 2007). Next, we discuss the different types of ecosystem coordination.

3. Coordination of Innovation Ecosystems

Managing innovation ecosystems or networks is not a new issue, but discussion on the phenomenon has been on the rise in recent years (Möller and Halinen, 2017; McDermott, Mudambi, and Parente, 2013). As a result of those relations' complexity, it becomes necessary to understand which is the best model of management (Lumineau and Oliveira, 2018; Majchrzak et al., 2015). The process of innovation is a multifaceted and complex task (Pikkarainen, Ervasti, Hurmelinna-Laukkanen, and Nätti, S., 2017), even more in environments where there is a significant number and diversity of actors (Reypens, Lievens and Blazevic, 2021), as the case of innovation ecosystems. Thus, innovation ecosystems' success calls for careful direction and coordination (Hurmelinna-Laukkanem and Nätti, 2018).

According to the literature, it is possible to identify different approaches that seek to understand how these ecosystems can be managed. Most discussions of management/coordination of networks of inter-organizational relations are related to the concept of network governance (Provan and Milward, 2001; Provan, Isett and Milward, 2004). However, when it comes to innovation networks or ecosystems, the most used approaches have been orchestration (Hurmelinna-Laukkanem and Natti, 2018; Pikkarainen et al, 2017; Dhanaraj and Parkhe, 2006) and choreography (Ferraro and Iovanella, 2015). We notice that each of these lenses brings different perspectives in relation to the maturity of the ecosystem or network, complexity of relationships, and management's centralization.

Provan and Kenis (2008) identified three basic network governance modes from which hybrid models can be generated. The simplest mode is shared governance, where a group of organizations works collectively as a network despite not possessing a structure of exclusive and formal management. The second mode is the lead organization-governance, which typically

occurs in relationships formed by a bigger, more powerful organization and a set of lesser, weaker firms (Provan and Kenis, 2008). The third mode is the network administrative organization (NAO), where an administrative entity is created especially to manage the network and its activities.

According to Provan and Kenis' (2008) proposal, four contextual variables act as key predictors of the effectiveness of network governance modes: the level of trust among network members, the number of participants, the level of goal consensus, and the need for network-level competencies. The relationship between these predictors should enable identifying the mode of governance best suited to the network, as no mode of governance is necessarily superior in every situation. However, choosing the best mode of governance is not a guarantee of success. As stated by Provan and Kenis (2008, p. 14)," network managers operating within each form must recognize and respond to three basic tensions, or contradictory logics, that are inherent in network governance". These tensions refer to the efficiency of the network versus the inclusiveness of its members in decisions and deliberative activities, the internal versus external legitimacy of the network, and the flexibility versus stability of the network. The management of these tensions is critical to the efficacy of the network: 'Despite the absence of empirical research on how these three tensions occur regarding network governance, they are an essential, but problematic, aspect of network management (Provan and Kenis, 2008, p. 18)

However, we realize that the term governance, widely used in networks, clusters, and business arrangements, focuses on institutional organization, a meso perspective. Thus, in broader networks - such as innovation ecosystems - approaches such as orchestration and choreography have been used, seeking to contemplate this type of network's fluidity. Dhanaraj and Parkhe (2006) originally defined the orchestration model as the set of deliberate, purposeful actions undertaken by a central actor to create and extract value from a network. The orchestration of innovation networks is a theoretical approach that focuses on the organization and the leadership in multi actors' relations (Young, 1982; Mintzberg, 1998; Dhanaraj and Parkhe, 2006). Such capacity may cover different processes according to its applicability, comprehending a set of actions conducted by one orchestrator (Dhanaraj and Parkhe, 2006; Nambisan and Sawhney, 2011; Hurmelinna-Laukkanen, Möller and Nätti, 2011).

Network orchestration denotes the act of performing a leadership role, without the benefit of hierarchical authority. Orchestration emerges as a set of activities aimed at developing, managing, and coordinating a set of actors that seek to create and extract value from the network (Dhanaraj and Parkhe, 2006). Fung, Fung and Wind (2007) support that

definition bringing the orchestration as a capacity to unite several different expertise so that there is a harmony capable of creating value. "It is about activities that allow and ease (but do not dictate) the coordination of the network for the performance of the results of innovation" (Ritala, Hurmelinna-Laukkanem, and Nätti, 2012, p. 325).

In the seminal paper, Dhanaraj and Parkhe (2006) developed three processes based on other more specific variations and for the descriptions of the orchestration of the innovation networks: mobility of knowledge, appropriability of innovation and network stability. Nevertheless, the processes and the model proposed by Dhanaraj and Parkhe (2006) are being increasingly questioned due to the emergence of more complex and heterarchical networks.

Usually, the orchestration of an innovation network was performed by a hub company (Dhanaraj and Parkhe, 2006). However, in some situations, the roles and the activities of network coordination for the performance of innovation results can go beyond the model based on the set of actions of a hub company when considering all the network (Hurmelinna-Laukkanem and Nätti, 2018). The studies have been pointing out that multiple orchestrators with distinct roles can generate more innovations for the organizations and networks (Hurmelinna-Laukkanem and Natti, 2018), besides having identified that the orchestration influences differently the individual and organizational levels (Ritala, Armila and Blomqvist, 2009). Therefore, the orchestration varies according to the stage of network development (Nilsen and Gausdal, 2017). To summarize, we can identify two theoretical lines in the orchestration approach: the first advocated by Dhanaraj and Parkhe (2006) with centralized management in a hub company and the second line that presents a decentralized model with multi-orchestrators (Hurmelinna-Laukkanem and Nätti, 2018; Pikkarainen et al., 2017).

More complex and heterarchical organizations have emerged with more than one hub, in which the power of decisions is spread among all partners. When this occurs, the orchestration model is no longer suitable to describe such an environment (Ferraro and Iovanella, 2015). In this context, Ferraro and Iovanella (2015) introduce the choreography model, which considers all members of the network without relying on one core actor. The choreography governs behaviors by shaping the level of connectivity and cohesion among network members. It represents a valid organizational system that can sustain certain activities and achieve effects that generate innovation outcomes.

The word "choreography" is derived from the Greek words for "dance" χορεια and "write" γραφια, reflecting the sequence of steps and movements in dance, and the art or the practice of designing choreographic sequences. The emergence of choreography in a network

leads to the establishment of coordinated activities among all members, which allow the creation and extraction of innovation through the outcomes (Ritter et al., 2004). This last piece of evidence suggests developing a new framework, called "choreography," defined as the network's capacity to address collaboration among multiple members. The presence of choreography results in the establishment of coordinated activities among all members and produces heightened innovation (Ferraro and Iovanella, 2015).

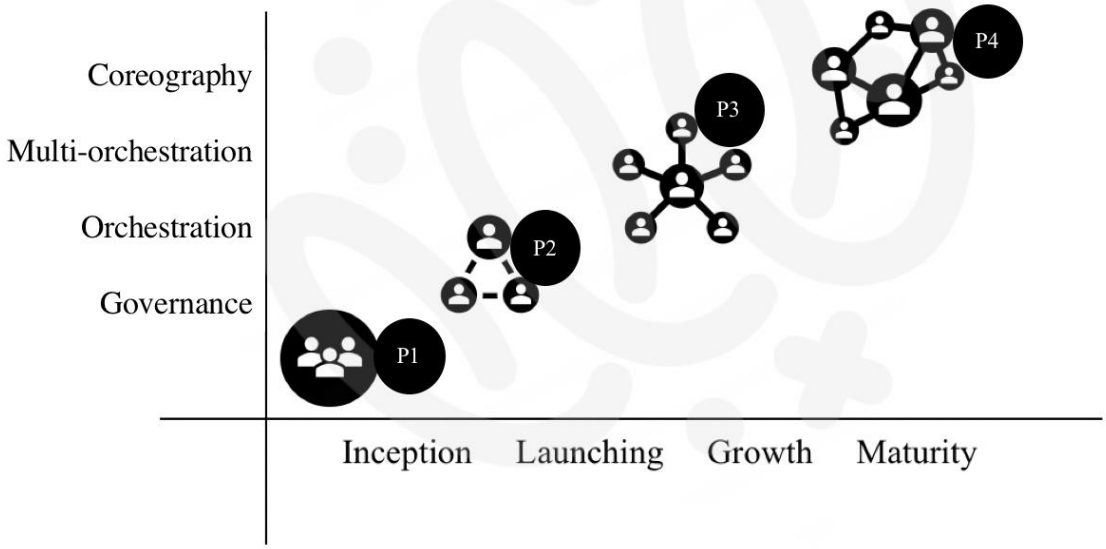
Choreography is focused on inter-organization coordination for external perspectives (Nambisan and Sawhney, 2011), while self-organizing interactions address collaboration. Ferraro and Iovanella (2015) argues that the emergence of choreography involves the performance of specific activities among the members of the innovation network, which are: a) management of the flow of knowledge, b) management of the appropriability of innovation, c) management of the stability of the and d) management of the vitality and health of the network. Such activities are similar to the key processes required for a hub in orchestration, but with the difference that the choreography is self-organized (Ferraro and Iovanella, 2015).

To summarize, we identified that the relationship between orchestration and choreography is related to the networks' complexity and the centralization of its coordination. Thus, the orchestration appears to seek to explain simpler networks coordinated by a hub company. As the literature presented more complex networks, it was noticed that the number of orchestrators was increasing. Finally, there is the choreography approach that offers a totally decentralized model for increasingly complex networks. In the next section, we seek to explain how the ecosystem's coordination can change according to its life cycle and, therefore, its complexity.

4. Actors' Coordination in the Life Cycle of Innovation Ecosystems

According to the life cycle and coordination approaches for innovation ecosystems, we identified different strategies of coordination that are more effective to engage and mobilize actors for joint actions in the development of an innovation ecosystem. In the initial stages of an innovation ecosystem's life cycle, networks are simpler and thus the coordination issues are less difficult. However, as the ecosystem evolves and the complexity of the networks increases, a more sophisticated strategy, such as orchestration or choreography, is needed, as shown in Figure 4.

Figure 4. Framework of Actors' Coordination in the Life Cycle of Innovation Ecosystems



In the inception stage, actors are dispersed, and resources are not mobilized. Thus, a strategy is needed to mobilize the actors, align actions and define common objectives and agendas. In this stage, it is also when trust starts to be built. Hence, to ensure cooperation while still are low levels of trust among the actors, the most effective control mechanism will be a more centralized one, such as governance. This finding raises our first proposition (P1):

P1: During the inception stage of an innovation ecosystem, coordination is centralized through a governance structure to mobilize actors, align actions and propose a common strategy.

The same happens in the next stage when the ecosystem has the basic infrastructure for innovation and the actors start to be articulated and resources mobilized. However, the ecosystem dynamics are not well organized yet, and trust among actors is still scarce; thus the potential of resources cannot be fully exploited. In this stage there is still a need for trust-building and a formal mechanism of control. Therefore, in both the inception and in the launching stages, the ecosystem calls for more centralized coordination. However, in the latter there is already a simple network to be coordinated, which can be done through an orchestration strategy and a hub organization. Our second proposition arises from this finding:

P2: During the launching stage of an innovation ecosystem, a simple network is formed, so orchestration becomes necessary.

In the subsequent stages, actors already trust each other and collaborate better. In the growth stage, it is possible to observe that actors can manage their own interdependencies for the ecosystem to benefit from their actions. However, the coordination in this phase becomes

more complex as well as the networks themselves. Hence, the coordination mechanism to be adopted must maintain a certain degree of responsibility and control, but which doesn't plaster the behavior of actors or the evolution of the ecosystem. This way, decentralization allows that multiple leaders (multi-orchestrators) take control over the ecosystem coordination. Accordingly, we present our third proposition:

P3: During the growth stage of an innovation ecosystem, the network of actors becomes more complex and the number of members increases, making multi-orchestration necessary.

Finally, in the maturity stage, it is possible to suppose that are high levels of trust among actors and that the ecosystem can compete internationally against other ecosystems. The mature ecosystem is a rich environment supportive of innovation where innovation happens systematically and organically. In this stage, a highly decentralized mechanism of coordination is possible and effective. The actors already understand their roles and can communicate and articulate with other actors without any intermediary. In the maturity phase, the alignment of actors is already built, and they can complement each other to strengthen the ecosystem. This last coordination mechanism, in which it is possible to have a shared leadership in the process of self-organization, is called "choreography". Thus, we have our fourth proposition:

P4: During the maturity stage of an innovation ecosystem, there are high levels of trust and alignment between the actors, making it possible to adopt choreography as the coordination mechanism.

5. Conclusion

Innovation ecosystems are of utmost importance for territorial development. For that to happen, the quadruple helix actors must be engaged in joint actions that effectively contribute to a better ecosystem. However, there is a challenge regarding how to coordinate these actors, given they may have not just common objectives but also conflicting interests. According to their life cycle stage, innovation ecosystems can have distinct coordination mechanisms. For each stage, we identified a better coordination strategy.

Therefore, in this paper, we propose a need for more control in the first stages of the innovation ecosystem to align the actors and their interests. Thus, in the inception stage, innovation ecosystems call for a formal coordination system. Given its dynamics are not well organized, trust among actors must be built from scratch, and actors and resources must be mobilized. In the launching stage, there is an evolution since the necessary infrastructure is

ready. However, actors still need to be articulated, and trust still needs to be built; thus, centralized coordination is better. However, in the subsequent stages, the networks become more complex and require a coordination mechanism that allows decentralization. Then, in the growth stage, the orchestration of actors and resources enables an adequate degree of decentralization, reaching multiple orchestrators' development. Finally, in the last stage, maturity, it is possible to have choreography as an organic coordination mechanism, in which leadership is shared in a self-organization process.

An effective coordination mechanism for each phase of an innovation ecosystem's life cycle can be of great value for all the actors and the ecosystem itself. The benefits for the ecosystem include better quality of life and a more developed city. For the actors, there are also many benefits in joining a collective movement for innovation, such as access to complementary resources, knowledge spillovers, and more competitiveness.

Knowing which coordination mechanism is the most suitable for each life cycle stage of an innovation ecosystem can help both practitioners and researchers achieve their respective objectives. For public managers, ecosystem builders, and other leaders and executives in general, our framework can provide a map for understanding the dynamics and evolution of the ecosystems they are in, giving insights for more accurate interventions. This paper also advances the literature on innovation ecosystems, especially regarding understanding the life cycle stages and the most appropriate coordination mechanism for each stage. Thus, this study's four propositions can strengthen the knowledge in these topics, which still need further exploitation within the field of innovation ecosystems.

This theoretical paper is a first attempt at explaining how it works in the coordination of innovation ecosystems. Our framework opens an avenue for future studies that can help in validating our model. First, it would be valuable to verify in practice the validity of the four propositions we listed in this paper and its central argument that there is a coordination mechanism that suits the most for each stage of the life cycle of an innovation ecosystem. Both quantitative and qualitative studies can be carried out to validate our theoretical propositions. For example, to perform an empirical test, further research should propose a scale to measure innovation ecosystems' life cycle stage and the corresponding coordination level. It is also possible to have new papers exploring case studies on each strategy and life cycle or developing a multiple case study comparing different ecosystems' strategies, among others.

References

Autio, E., & Thomas, L. (2014). Innovation Ecosystems: Implications for Innovation Management? in Dodgson, M., Gann, D. M., & Phillips, N. (Eds.). *The Oxford handbook of innovation management*. Oxford University Press, Oxford, pp. 204-288.

Betz, M. R., Partridge, M. D., & Fallah, B. (2016). Smart cities and attracting knowledge workers: Which cities attract highly-educated workers in the 21st century?.*Papers in Regional Science*, Vol. 95 No. 4, pp. 819-841.

Bittencourt, B. A., Zen, A. C., & Santos, D. A. G. (2020). Orchestrating University Innovation Ecosystem: the case of a Brazilian University. *Revue Internationale d'Intelligence Économique,* Lavoisier. hal-02865709

Bittencourt, B.A., Zen, A.C., Schmidt, V., & Wegner, D. (2018), The orchestration process for emergence of clusters of innovation, *Journal of Science and Technology Policy Management*, Vol. 11 No. 3, pp. 277-290.

Borkowska, K. & Osborne, M. (2018). Locating the fourth helix: Rethinking the role of civil society in developing smart learning cities. *International Review of Education,* Vol. 64**,** pp. 355–372.

Cantner, U., Cunningham, J. A., Lehmann, E. E., & Menter, M. (2020). Entrepreneurial ecosystems: a dynamic lifecycle model. *Small Business Economics*, pp. 1-17.

Carayannis, E. G., & Campbell, D. F. (2009). 'Mode 3' and 'Quadruple Helix': toward a 21st century fractal innovation ecosystem. International Journal of Technology Management, Vol. 46 No. 3-4, pp. 201-234.

Carayannis, E. G., Grigoroudis, E., Campbell, D. F., Meissner, D., & Stamati, D. (2018). The ecosystem as helix: an exploratory theory-building study of regional co-opetitive entrepreneurial ecosystems as Quadruple/Quintuple Helix Innovation Models. *R&D Management*, Vol. 48 No. 1, pp. 148-162.

Dhanaraj, C.; Parkhe A. (2006). Orchestrating innovation networks. *Academy of Management Review.* Vol. 31 No. 3, pp. 659-669.

Diamandis, P. H., & Kotler, S. (2020). *The Future Is Faster Than You Think:* How Converging Technologies Are Transforming Business, Industries, and Our Lives. Simon & Schuster, New York, NY.

Dirks, S., Gurdgiev, C., & Keeling, M. (2010). Smarter cities for smarter growth: How cities can optimize their systems for the talent-based economy. *IBM Institute for business Value*, available at: http://ssrn.com/abstract=2001907 Dyer, J. H., & Hatch, N. W. (2006). Relation-specific capabilities and barriers to knowledge transfers: creating advantage through network relationships. *Strategic Management Journal*, Vol. 27 No. 8, pp. 701-719.

Dyer, J. H., Singh, H., & Hesterly, W. S. (2018). The relational view revisited: A dynamic perspective on value creation and value capture. *Strategic Management Journal*, Vol. 39 No. 12, pp. 3140-3162.

Engel, J. S., Berbegal-Mirabent, J., & Piqué, J. M. (2018). The renaissance of the city as a cluster of innovation. *Cogent Business & Management*, Vol. 5 No. 1, pp. 1-20.Engel, J. S., & del-Palacio, I. (2009). Global networks of clusters of innovation: Accelerating the innovation process. *Business horizons*, Vol. 52 *No.* 5, pp. 493-503.Etzkowitz, H., & Leydesdorff, L. (2000). The dynamics of innovation: from National Systems and "Mode 2" to a Triple Helix of university–industry–government relations. *Research Policy*, Vol. *29* No. 2, pp. 109-123.

European Union (2016). Regional Innovation Ecosystems: Learning from the EU's Cities and Regions, available at: https://s3platform.jrc.ec.europa.eu/documents/20182/84453/Regional+Innovation+Ecosystems/48ab5553-489b-4c41-89b4-5c897e3ef066

Ferraro, G. & Iovanella, A. (2015). Organizing Collaboration in Inter-organizational Innovation Networks, from Orchestration to Choreography. *International Journal of Engineering Business Management,* Vol. 7 No. 24, pp; 1-14.

Fung, V. K., Fung, W. K., & Wind, Y. J. R. (2007). *Competing in a flat world: building enterprises for a borderless world*. Pearson Prentice Hall, Upper Saddle River, NJ.

Heaton, S., Siegel, D. S., & Teece, D. J. (2019). Universities and innovation ecosystems: a dynamic capabilities perspective. *Industrial and Corporate Change,* Vol. 28 No. 4, pp. 921-939.

Hurmelinna-Laukkanen, P., & Nätti, S. (2012). Network orchestration for knowledge mobility: the case of an international innovation community. *Journal of Business Market Management*, Vol. 5 No. 4, pp. 244-264.

Hurmelinna-Laukkanen, P., & Nätti, S. (2018). Orchestrator types, roles and capabilities – A framework for innovation networks. *Industrial Marketing Management,* Vol. 74, pp. 65–78.

Hurmelinna-Laukkanen, P., Möller, K., & Nätti, S. (2011), "Innovation orchestration matching network types and orchestration profiles", 27th Industrial Marketing and Purchasing Conference (IMP), Industrial Marketing and Purchasing Group (IMP), 1-3 September ,Glasgow, avaiable at: https://www.impgroup.org/paper_view.php?viewPaper=7684

Lumineau, F., & Oliveira, N. (2018). A pluralistic perspective to overcome major blind spots in research on interorganizational relationships. *Academy of Management Annals,* Vol. 12, pp. 440-465.

Majchrzak, A., Jarvenpaa, S. L., & Bagherzadeh, M. (2015). A review of interorganizational collaboration dynamics. *Journal of Management*, Vol. 41, pp. 1338-1360.

McDermott, G., Mudambi, R., & Parente, R. (2013). Strategic modularity and the architecture of multinational firm. *Global Strategy Journal,* Vol. 3 No.1, pp. 1–7.

Menzel, M. P., & Fornahl, D. (2010). Cluster life cycles—dimensions and rationales of cluster evolution. *Industrial and Corporate Change*, Vol. 19 No. 1, pp. 205-238.

Mintzberg, H. (1998) Covert leadership: Notes on managing professionals. *Harvard Business Review*. Vol. 76, pp. 140-148.

Möller, K. & Halinen A. (2017). Managing business and innovation networks: From strategic nets to business fields and ecosystems. *Industrial Marketing Management,* Vol. 67, pp. 5-22

Moore, J. F. (1993). Predators and prey: a new ecology of competition. *Harvard Business Review*, Vol. 71 No. 3, pp. 75-86.

Nambisan S., & Sawhney, M. (2011). Orchestration Processes in Network-Centric Innovation: Evidence From the Field. *Academy of Management Perspectives,* Vol. 25, pp. 40–57.

Nilsen, E. R., & Gausdal, A. H. (2017). The Multifaceted Role of The Network Orchestrator: A Longitudinal Case Study. *International Journal of Innovation Management,* Vol. 21 No. 06.

Pikkarainen, M., Ervasti, M., Hurmelinna-Laukkanen, P., & Nätti, S. (2017). Orchestration roles to facilitate networked innovation in a healthcare ecosystem. *Technology Innovation Management Review*, Vol. *7* No. 9, pp. 30-43.Piqué, J. M., Berbegal-Mirabent, J., & Etzkowitz,

H. (2018). Triple helix and the evolution of ecosystems of innovation: the case of Silicon Valley. *Triple Helix*, Vol. *5* No. 1, pp. 1-21.

Piqué, J. M., Miralles, F., & Berbegal-Mirabent, J. (2018). Application of the Triple Helix Model in the Creation and Evolution of Areas of Innovation. In *International Triple Helix Summit* (). Springer, Cham, pp. 223-244

Piqué, J.M., Miralles, F., & Berbegal-Mirabent, J. (2019). Areas of Innovation in Cities: The evolution of 22@Barcelona. *International Journal of Knowledge-Based Development*, *10*(1), 43-74.

Powell, W.W., & S. Grodal (2005). Networks of Innovators, in Fagerberg, J., Mowery, D. C., & Nelson, R. R. (Ed.), *The Oxford Handbook of Innovation*, . Oxford University Press, Oxford, pp. 56-85

Presutti, M., Boari, C., & Majocchi, A. (2013). Inter-organizational geographical proximity and local startups' knowledge acquisition: a contingency approach. *Entrepreneurship & Regional Development*, Vol. 25, No. 5-6, pp. 446-467.

Provan, K. G., & Kenis, P. (2008). Modes of network governance: Structure, management, and effectiveness. *Journal of Public Administration Research and Theory*, Vol. 18 No. 2, pp. 229-252.

Provan, K. G., & Milward, H. B. (2001). Do networks really work? A framework for evaluating public-sector organizational networks. *Public Administration Review*, Vol. 61 No. 4, pp. 414-423.Reynolds, E. B., & Uygun, Y. (2018). Strengthening advanced manufacturing innovation ecosystems: The case of Massachusetts. *Technological Forecasting and Social Change*, Vol. 136, pp. 178-191.

Provan, K. G., Fish, A., & Sydow, J. (2007). Interorganizational networks at the network level: A review of the empirical literature on whole networks. *Journal of Management*, Vol. 33 No. 3, pp. 479-516.

Provan, K. G., Isett, K. R., & Milward, H. B. (2004). Cooperation and compromise: A network response to conflicting institutional pressures in community mental health. *Nonprofit and voluntary sector quarterly*, Vol. 33, No. 3, pp. 489-514.

Reypens, C., Lievens, A., & Blazevic, V. (2021). Hybrid Orchestration in Multi-stakeholder Innovation Networks: Practices of mobilizing multiple, diverse stakeholders across organizational boundaries. *Organization Studies*, Vol. 42 No. 1, pp. 61–83.

Ritala P., Armila L., & Blomqvist K. (2009) Innovation orchestration capability: defining the organizational and individual level determinants. *International Journal of Innovation Management*. Vol. 13 No. 4, pp.569-591.

Ritala, P., Hurmelinna-Laukkanen, P., & Nätti, S. (2012). Coordination in innovation-generating business networks – the case of Finnish Mobile TV development. *Journal of Business & Industrial Marketing*, No. 27, pp. 324-334.

Ritter, T., Wilkinson, I. F., & Johnston, W. J. (2004). Managing in complex business networks. *Industrial Marketing Management*, Vol. 33 No. 3, pp. 175-183.

Spigel, B., & Harrison, R. (2018). Toward a process theory of entrepreneurial ecosystems. *Strategic Entrepreneurship Journal*, Vol. 12 No. 1, pp. 151-168.

Suominen, A., Seppänen, M., & Dedehayir, O. (2019). A bibliometric review on innovation systems and ecosystems: a research agenda. *European Journal of Innovation Management*, Vol. 22 No. 2, pp. 335-360.

Yawson, R. M. (2009, June). The ecological system of innovation: A new architectural framework for a functional evidence-based platform for science and innovation policy, in *The Future of Innovation Proceedings of the XXIV ISPIM 2009 Conference*, 21-24 June, Vienna.

Young, D. (1982) Organization and Orchestra: Lesson from the Pit. *Journal of Policy Analysis and Management*, Vol. 1 No. 2 Winter, pp. 264-267.

Zen, A. C., Santos, D. A. G., Faccin, K., & Gonçalves, L. F. (2019). Mapeamento do Ecossistema de Inovação: Percepções e Desafios, available at: https://pactoalegre.poa.br/downloads

6. FINAL REMARKS

The definition of strategies for coordinating actors and resources in innovation ecosystems can drive the evolution of these ecosystems. However, for IEs to evolve it is necessary to identify what are its main actors and resources, as well as engage them and stimulate their collaboration for the development of collaborative projects and the structuring of an initial governance structure. Having identified the actors and relational resources of the ecosystem, one should seek the most appropriate coordination strategy for these actors and resources, so that the former understands and perform their respective roles in the ecosystem and the latter have their potential exploited to the maximum.

The four papers that compose this doctoral dissertation aimed to answer to the following objective: to analyze how actors and resources are coordinated in innovation ecosystems. This understanding is necessary due to the growing importance of innovation ecosystems for locoregional socioeconomic development.

In the first paper, entitled **Mapping, Analyzing, and Designing Innovation Ecosystems in Cities: an Action Research Approach**, we propose and apply a method for map, analyze, and design IEs in cities through the engagement of quadruple helix actors and exploitation of strategic resources. We argue that the development of an innovation ecosystem initially depends on mapping its quadruple helix actors - from academia, society, government, and companies - and stimulating engagement and collaboration among them through co-creation processes aiming at identifying the local challenges and resources of the ecosystem and making the IE able to generate and deliver value to all its stakeholders.

In order to achieve that purpose, we collected indicators and employed the Action Research (AR) approach, alongside Design Thinking (DT), in five workshops in which participated 135 people from the quadruple helix in the IE of Porto Alegre, Brazil. AR and DT enabled the involvement of the researchers with the object of the research and collaboration among actors in cocreation processes. As contributions, we provided evidence for the use of AR in innovation research a cohesive and translation of tacit knowledge into scientific knowledge through the intervention of researchers. Moreover, we provided a systematic approach on how to nurture innovation ecosystems in cities for their emergence and a method for mapping innovation ecosystems in cities through the engagement and collaboration between the quadruple helix actors and use of DT tools. We also found that Design Thinking can improve innovation processes at an inter-organizational and meso level of analysis

In the second paper, entitled **Orchestration of Actors and Resources in Innovation Ecosystems**, from the understanding of who are the actors of the ecosystem and how they can be engaged in collaborative projects, it is understood that there must be an orchestration of these actors and relational resources in order for the ecosystem to become more competitive and achieve sustainable competitive advantage.

Hence, this paper aimed to propose a theoretical model on the role of orchestration of actors and resources in creating sustainable competitive advantage in innovation ecosystems. We propose a classification of actors and relational resources in innovation ecosystems at the city level. Next, we also propose an orchestration model of innovation ecosystems based on the orchestration of actors and relational resources and an analysis framework. This paper is the basis for the following paper, which seeks to empirically validate the argument that the orchestration of actors and relational resources in innovation ecosystems can lead the ecosystem to obtain sustainable competitive advantage.

The third paper, entitled **Orchestration of Actors and Resources in Innovation Ecosystems: an empirical perspective**, sought to empirically validate the argument constructed in paper two and generate insights from interviews with 20 experts in the innovation ecosystem of Porto Alegre, each helix – academia, government, society and companies – being represented by five specialists.

In this paper, we explored the role of the orchestration of actors and relational resources and highlighted the importance of the later, specially its leverage, in the development of innovation ecosystems and in the achievement of sustainable competitive advantage. We also found that that orchestration is an effective strategy for the management of innovation ecosystems, mostly when especially when the ecosystem is in a stage of evolution between initial and intermediate and it is necessary to strengthen the articulation between the actors and the leverage of relational resources. Moreover, we validated a framework to analyze different innovation ecosystems and for practitioners to drive innovation ecosystems towards better development and prosperity.

Finally, in the fourth paper, entitled **From Governance to Choreography: Coordination of Innovation Ecosystems**, we reunite the insights generated by the three first papers to propose a new framework for the coordination of innovation ecosystems, considering that IEs have life cycle stages and that for each stage there is a more appropriate coordination strategy.

In methodological terms, we used three different methods among the four papers that make up this dissertation to propose a model of how actors and relational resources are coordinated for the development of innovation ecosystems.

Action Research was the method used in the first paper, in which, through cocreative workshops with Design Thinking tools, it was possible for researchers to immerse themselves in the problem situation, understanding the context and object of analysis and at the same time proposing solutions to the challenges identified, together with people who experience the challenges in their everyday lives (Pruitt & Adlin, 2006). In these workshops, we brought together a large number of actors (135) of the quadruple helix of innovation ecosystems – people from academia, government, companies and civil society – and engaged them in collaborative processes to capture theoretical insights and generate practical results. Through this method, it was possible to transform the tacit knowledge of the actors into scientific knowledge.

The theoretical essay method method was used in the second and fourth papers. The theoretical essays presented in this dissertation aim, from a reflexive and interpretative nature (Meneghetti, 2011), and from a deep analysis of the existing literature, to produce questions and knowledge about the development of innovation ecosystems and the mechanisms of coordination of actors and relational resources within them.

Finally, the third paper dealt with a case study in an innovation ecosystem in development, seeking to validate empirically the argument of paper two and serving as the main basis for the propositions we made on paper four. This multimethod configuration of the dissertation in question allows combining complementary research methods (Morse, 2003) with the objective of contributing to the construction of new theoretical knowledge and practical application.

6.1 Theoretical and Managerial Contributions

Table 8 presents the papers' main contributions and results.

Table 8: Papers' contributions and results

Paper	Objective	Contributions	Key results
Mapping, Analysing, and Designing Innovation Ecosystems in Cities: an Action Research Approach	To propose and apply a method for map, analyze, and design IEs in cities through the engagement of quadruple helix actors and exploitation of strategic resources.	Cohesive and systematic approach on how to nurture innovation ecosystems in cities for their emergence Method for mapping innovation ecosystems in cities through the engagement and collaboration between the quadruple helix actors Use of action research in innovation research.	Engagement of quadruple helix actors in co-creation processes through the use of design thinking tools Translation of tacit knowledge into scientific knowledge through the intervention of researchers. Design Thinking can improve innovation processes at an inter-organizational and meso level of analysis
Orchestration of Actors and Resources in Innovation Ecosystems	To propose a theoretical model on the role of orchestration of actors and resources in creating sustainable competitive advantage in innovation ecosystems.	Theoretical model on the role of orchestration of actors and resources in creating sustainable competitive advantage in innovation ecosystems.	Framework for analyzing the orchestration of actors and resources in innovation ecosystems to obtain sustainable competitive advantage.
Orchestration of Actors and Resources in Innovation Ecosystems: an empirical perspective	To analyze how actors and relational resources are orchestrated so that innovation ecosystems can achieve sustainable competitive advantage	Exploring the role of the orchestration of actors and relational resources in creating sustainable competitive advantage for innovation ecosystems Validating a framework to analyze different innovation ecosystems and to drive ecosystems towards the achievement of sustainable competitive advantage	Identification of relational resources and its leverage for the development of innovation ecosystems. Orchestration as an effective strategy for the management of innovation ecosystems
From governance to choreography: coordination of Innovation Ecosystems	To analyze the coordination strategies of the actors throughout the life cycle of innovation ecosystems	Framework of actors coordination in innovation ecosystems. Coordination strategies for each stage of an innovation ecosystem life cycle. Four propositions: coordination in inception stage; coordination in launching stage; coordination in growth stage; coordination in maturity stage.	Each stage of an innovation ecosystem's life cycle – inception, launching, growth and maturity – demands different coordination strategies – governance, orchestration, multiple orchestration or choreography.

Source: Author

The method used in the first paper proved to be valid to generate new knowledge, especially in the field of innovation, given its potential to transform tacit knowledge into scientific knowledge. Thus, the application of action research in conjunto with Design Thinking tools made it possible to generate different insights of when more traditional methods of research are used and opens new possibilities for future research investigating the development of collaborative processes of innovation and open innovation. Moreover, this research also demonstrates how both action research and Design Thinking can be used in meso and interorganizational analysis levels and in research that requires the direct action of researchers.

Action research combined with Design Thinking can facilitate co-creation processes between actors with diffuse individual interests, engaging them in common goals through a focus on identifying and solving challenges and centrality in people. Such an approach can also serve as a guide and it provides a toolkit for the development of innovation ecosystems, helping both policymakers, managers and other interested stakeholders to promote collaborative innovation processes among the actors of the quadruple helix.

In turn, paper two presents as one of its main theoretical contributions the explicit identification of the main groups of actors and resources of innovation ecosystems. Moreover, it promotes the connection between the literatures of innovation ecosystems and Resource-Based View (RBV), since both consider the interdependence between actors and resources and, especially from its relational perspective, the RBV also points out the benefits generated together by resources of a network of actors. Furthermore, the application of RBV to new contexts and levels of analysis – such as ecosystems – is an opportunity for advances in research and wealth creation in practice (Alvarez & Barney, 2017).

On this same approach, the identification of the orchestration of actors and resources in innovation ecosystems, especially territorial ecosystems and more specifically ecosystems at the city level, as an important coordination strategy is also shown a great theoretical contribution of the paper. Thus, we propose a framework for analysis of this orchestration, which can assist researchers in the analysis and generation of new knowledge for ecosystems at different stages of their life cycle. For policymakers, managers and other actors, this framework can also assist in identifying the main actors and relational resources of the ecosystem, as well as in the elaboration of an effective orchestration strategy for specific ecosystems.

The third paper validates the framework and the analysis dimensions presented on paper 2 and provide empirical insights on what are the main drivers of the orchestration of actors and

resources in innovation ecosystems. We provided evidence on the role of trust and strategies used by the orchestrators to lead the ecosystem. Moreover, we identified that intellectual capital, especially from the universities, and collective movements can stimulate building and leveraging relational resources for the ecosystem to achieve sustainable competitive advantage. Empirically, this research can guide practitioners and orchestrators in guiding the development of innovation ecosystems through an orchestration strategy.

Finally, the last paper builds upon the insights from papers one to three and provides a new analysis framework, built upon four propositions and which considers the different possibilities of coordination strategies and makes a relationship with innovation ecosystem's life cycle stage.

These propositions imply that for an adequate management of innovation ecosystems, several factors must be considered, especially contextual ones. It is necessary to understand the maturity of the ecosystem and the stage of the life cycle it is in, in order to deliberate on the most appropriate coordination strategy - for example, whether a more centralized and formal form or a more decentralized and organic one. More specifically, it is also critical to consider the levels of trust and the complexity of the networks that make up the ecosystem.

Therefore, this last paper consolidates this dissertation and generates insights for managerial interventions, such as coordinating networks of actors, relational resources and knowledge spillovers, driving the evolution of the ecosystem to provide better transfer of knowledge, creation of knowledge-based startups, and human capital formation, among others, and essentially deploying actions that contribute to better quality of life and local or regional development. Moreover, it opens up new possibilities for future research as it presents an unprecedented argument that directly links each proposed coordination strategy - governance, orchestration, multiple orchestration and choreography - with each of the stages of the ecosystem's life cycle - inception, launching, growth, and maturity.

Therefore, this dissertation argues that there is a coordination of the evolution process of a developing innovation ecosystem and that each stage of the life cycle of this ecosystem demands different coordination strategies. This conclusion is especially directed to the territorial approach of innovation ecosystems, focusing on innovation ecosystems delimited at the city level.

6.2 Limitations and Further Research

Despite its contribution, this dissertation has some limitations. First of all, all the four papers relate only to territorial innovation ecosystems, thus excluding platform ecosystems and other types of ecosystems – ex: business, knowledge, entrepreneurial, et. On papers one and three, the main limitation lies in its application to one case, a pilot case. Hence, further researches should extend the application of the method to mapping ecosystems and extend the analysis of actors and resources in innovation ecosystems to other contexts.

In addition, on paper one just Design Thinking and the tool of persona were applied in the analysis. Therefore, different approaches such as gamification, agile and design doing, among others, should be tested as well as other DT tools. Moreover, in the empirical setting of paper one, actors with high discrepancy of knowledge on innovation attended to the workshops. On the other hand, people with high level of knowledge on innovation were interviewed for the third paper. Thus, new research focusing on a more homogeneous group of actors in paper one and a more heterogeneous group in the paper three should be involved in order to provoke new insights from a different perspective.

In relation to papers two and four, we suggest new empirical studies, such as the one presented in paper three of this dissertation. In relation to paper two, we suggest empirical studies seeking to validate the framework in other ecosystems and even in other levels of territorial ecosystems, such as regions, states or departments, for example. In addition, it can also be verified what are the strategic relational resources in other ecosystems, comparing these ecosystems with each other and exploring how these ecosystems can strengthen their resources, in order to obtain sustainable competitive advantage. Similarly, regarding paper four, we suggest new studies seeking to validate the proposed framework. For both papers, there's an opportunity for quantitative studies, proposing a scale and measuring the processes and subprocesses resulting from the orchestration of networks and relational resources as well as the other coordination strategies, such as governance and choreography, and ranking the innovation ecosystems comparatively.

For paper three it was not possible to interview all of the subgroups of actors, such as representatives of large companies, investors, influencers, among others. We recommend the realization of new studies dealing with the perceptions of these other groups of actors. Both paper three and paper one deals with only one case – the innovation ecosystem of Porto Alegre. Therefore, we suggest that other ecosystems, in other settings – such as other innovation

ecosystems in Brazil or Latin America, ecosystems in developed countries or in other continents, among others.

REFERENCES

Acs, Z. J., Szerb, L., & Autio, E. (2015). National systems of entrepreneurship. In Acs, Z. J., Szerb, L., & Autio, E. *Global Entrepreneurship and Development Index 2014* (pp. 13-26). Cham: Springer International Publishing. Retrieved from: https://link.springer.com/book/10.1007%2F978-3-319-14932-5. https://doi.org/10.1007/978-3-319-14932-5

Acs, Z., Szerb, L., Lafuente, E., & Márkus, G. (2019). *Global Entrepreneurship and Development Index 2019*. Retrieved from: https://www.researchgate.net/publication/338547954_Global_Entrepreneurship_Index_2019

Adner, R. (2006). Match your innovation strategy to your innovation ecosystem. Harvard Business Review 84(4), 98.

Adner, R. (2017). Ecosystem as structure: An actionable construct for strategy. *Journal of Management*, *43*(1), 39-58. Retrieved from: https://journals.sagepub.com/doi/10.1177/0149206316678451 https://doi.org/10.1177/0149206316678451

Aliança para Inovação (2021). Retrieved from: https://alianca.pucrs.br/

Altrichter, H., Kemmis, S., McTaggart, R., Zuber-Skerritt, O. (2002). The concept of action research. The learning organization.

Alvarez, S. A., & Barney, J. B. (2017). Resource-based theory and the entrepreneurial firm. *Strategic entrepreneurship: Creating a new mindset*, 87-105. Retrieved from: https://onlinelibrary.wiley.com/doi/abs/10.1002/9781405164085.ch5 https://doi.org/10.1002/9781405164085.ch5

Alvedalen, J., & Boschma, R. (2017). A critical review of entrepreneurial ecosystems research: Towards a future research agenda. *European planning studies*, *25*(6), 887-903.

Arnkill, R., Järvensivu, A., Koski, P., Piirainen, T. (2010). Exploring Quadruple Helix Outlining User-Orientated Innovation Models. INTERREG IVC Programme.

Asheim, B. (2007). Differentiated knowledge bases and varieties of regional innovation systems. *Innovation*, *20*(3), 223-241.

Asheim, B. T., Boschma, R., & Cooke, P. (2011). Constructing regional advantage: Platform policies based on related variety and differentiated knowledge bases. *Regional studies*, *45*(7), 893-904.

Audretsch, D. B., & Belitski, M. (2017). Entrepreneurial ecosystems in cities: establishing the framework conditions. *The Journal of Technology Transfer*, *42*(5), 1030-1051. Retrieved from: https://link.springer.com/article/10.1007%2Fs10961-016-9473-8 https://doi.org/10.1007/s10961-016-9473-8

Autio, E., & Thomas, L. (2014). Innovation Ecosystems: Implications for Innovation Management? in Dodgson, M., Gann, D. M., & Phillips, N. (Eds.). *The Oxford handbook of innovation management*. Oxford University Press, Oxford, pp. 204-288.

Bandera, C., Thomas, E. (2018). The role of innovation ecosystems and social capital in startup survival. IEEE Transactions on Engineering Management 66(4), 542-551.

Bardin, L. (1977). *Análise de Conteúdo*. Martins Fontes.

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of management*, *17*(1), 99-120. Retrieved from: https://journals.sagepub.com/doi/10.1177/014920639101700108 https://doi.org/10.1177/014920639101700108

Barney, J. B., & Clark, D. N. (2007). *Resource-based theory: Creating and sustaining competitive advantage*. Oxford: Oxford University Press.

Barney, Jay B. (1997). *Gaining and sustaining competitive advantage*. Reading: Addison-Wesley Pub. Co.

Bathelt, H., Malmberg, A., Maskell, P. (2004). Clusters and knowledge: Local buzz, global pipelines, and the process of knowledge creation. Progress in human geography 28(1), 31-56.

Berrone, P., Ricart, J. E., Carrasco, C., Duch, A., 2016. IESE Cities in motion index 2016. Retrieved, 1, 2017.

Betz, M. R., Partridge, M. D., & Fallah, B. (2016). Smart cities and attracting knowledge workers: Which cities attract highly-educated workers in the 21st century?.*Papers in Regional Science*, Vol. 95 No. 4, pp. 819-841.

Bittencourt, B. A., Zen, A. C., & Santos, D. A. G. (2020). Orchestrating University Innovation Ecosystem: the case of a Brazilian University. *Revue Internationale d'Intelligence Économique*, Lavoisier. hal-02865709

Bittencourt, B.A., Zen, A.C., Schmidt, V., & Wegner, D. (2018), The orchestration process for emergence of clusters of innovation, *Journal of Science and Technology Policy Management*, Vol. 11 No. 3, pp. 277-290.

Boari, C., & Lipparini, A. (1999). Networks within industrial districts: Organising knowledge creation and transfer by means of moderate hierarchies. *Journal of management and Governance*, *3*(4), 339-360. Retrieved from: https://link.springer.com/article/10.1023%2FA%3A1009989028605

Boari, C., & Lipparini, A. (1999). Networks within industrial districts: Organising knowledge creation and transfer by means of moderate hierarchies. *Journal of management and Governance*, *3*(4), 339-360. Retrieved from: https://link.springer.com/article/10.1023%2FA%3A1009989028605

Borgatti, S. P., & Foster, P. C. (2003). The network paradigm in organizational research: A review and typology. *Journal of Management*, *29*(6), 991-1013. Retrieved from: https://www.sciencedirect.com/science/article/abs/pii/S0149206303000874?via%3Dihub https://doi.org/10.1016/S0149-2063(03)00087-4

Borkowska, K., & Osborne, M. (2018). Locating the fourth helix: Rethinking the role of civil society in developing smart learning cities. Retrieved from: *International Review of Education*, *64*(3), 355-372. Retrieved from: https://www.sciencedirect.com/science/article/abs/pii/S0149206303000874?via%3Dihub https://doi.org/10.1007/s11159-018-9723-0

Brasil (2021). Política Nacional de Inovação. Retrieved from: https://inovacao.mcti.gov.br/

Brown, T (2008). Design thinking. *Harvard Business Review* 86(6), 84.

Brown, T., Katz, B. (2009). *Change by Design*: How Design Thinking Transforms Organizations and Inspires Innovation. Harper Collins, New York.

Brydon-Miller, M., Greenwood, D., Maguire, P. (2003). Why action research? Action Research 1(1), 10.

Camboim, G. F., Zawislak, P. A., & Pufal, N. A. (2018). *Driving elements to make cities smarter: Evidences from European projects. Technological Forecasting and Social Change.* Retrieved from: https://www.sciencedirect.com/science/article/abs/pii/S0040162517318607?via%3Dihub https://doi.org/10.1016/j.techfore.2018.09.014

Camisón, C., & Forés, B. (2010). Knowledge absorptive capacity: New insights for its conceptualization and measurement. *Journal of Business Research*, *63*(7), 707-715.

Cantner, U., Cunningham, J. A., Lehmann, E. E., & Menter, M. (2020). Entrepreneurial ecosystems: a dynamic lifecycle model. *Small Business Economics*, pp. 1-17.

Carayannis, E. G., & Campbell, D. F. (2009). 'Mode 3' and 'Quadruple Helix': toward a 21st century fractal innovation ecosystem. International Journal of Technology Management, Vol. 46 No. 3-4, pp. 201-234.

Carayannis, E. G., Grigoroudis, E., Campbell, D. F. J., Meissner, D. & Stamati, D. (2018), The ecosystem as helix: an exploratory theory-building study of regional co-opetitive entrepreneurial ecosystems as Quadruple/Quintuple Helix Innovation Models. *R&D Management*, 48, 148-162. Retrieved from: https://onlinelibrary.wiley.com/doi/abs/10.1111/radm.12300 https://doi.org/10.1111/radm.12300

Cavallini, S., Soldi, R., Friedl, J., & Volpe, M. (2016). Using the quadruple helix approach to accelerate the transfer of research and innovation results to regional growth. *Consortium Progress Consulting Srl & Fondazione FoRmit*. Retrieved from: https://op.europa.eu/en/publication-detail/-/publication/6e54c161-36a9-11e6-a825-01aa75ed71a1

Cavallo, A., Ghezzi, A., & Balocco, R. (2019). Entrepreneurial ecosystem research: Present debates and future directions. *International Entrepreneurship and Management Journal*, *15*(4), 1291-1321.

Cennamo, C., & Santaló, J. (2019). Generativity tension and value creation in platform ecosystems. Organization Science, 30(3), 617-641.

CGEE - CENTRO DE GESTÃO E ESTUDOS ESTRATÉGICOS (2020). *Apêndice teórico da Estratégia Nacional de Inovação*. Brasília, DF: CGEE, 2021. 54 p.

Chan Kim, W., & Mauborgne, R. (1998). Procedural justice, strategic decision making, and the knowledge economy. *Strategic management journal*, *19*(4), 323-338.

Chesbrough, H. W. (2003). *Open innovation: The new imperative for creating and profiting from technology*. Harvard Business Press.

Coghlan, D., Brydon-Miller, M. (Eds.), 2014. The SAGE encyclopedia of action research. Sage.

Creswell, J. W. (2014). *Investigação Qualitativa e Projeto de Pesquisa-: Escolhendo entre Cinco Abordagens*. Penso Editora.

Cukier, W., Stolerick, K., Ngwenyama, O., Elmi M., 2016. Mapping the Innovation Ecosystem in Eastern Ontario: Inclusive Innovation. Institute for Information and Innovation Management, Toronto, Canada.

Dhanaraj, C., & Parkhe, A. (2006). Orchestrating innovation networks. *Academy of Management Review*, *31*(3), 659-669. Retrieved from: https://journals.aom.org/doi/10.5465/amr.2006.21318923 https://doi.org/10.5465/amr.2006.21318923

Diamandis, P. H., & Kotler, S. (2020). *The Future Is Faster Than You Think:* How Converging Technologies Are Transforming Business, Industries, and Our Lives. Simon & Schuster, New York, NY.

Dirks, S., Gurdgiev, C., & Keeling, M. (2010). Smarter cities for smarter growth: How cities can optimize their systems for the talent-based economy. *IBM Institute for business Value*, available at: http://ssrn.com/abstract=2001907 Dyer, J. H., & Hatch, N. W. (2006). Relation-specific capabilities and barriers to knowledge transfers: creating advantage through network relationships. *Strategic Management Journal*, Vol. 27 No. 8, pp. 701-719.

Dyer, J. H., & Singh, H. (1998). The relational view: Cooperative strategy and sources of interorganizational competitive advantage. *Academy of Management Review*, *23*(4), 660-679. Retrieved from: https://journals.aom.org/doi/10.5465/amr.1998.1255632 https://doi.org/10.5465/amr.1998.1255632

Dyer, J. H., Singh, H., & Hesterly, W. S. (2018). The relational view revisited: A dynamic perspective on value creation and value capture. *Strategic Management Journal*, *39*(12), 3140-3162. Retrieved from: https://onlinelibrary.wiley.com/doi/abs/10.1002/smj.2785 https://doi.org/10.1002/smj.2785

Edquist, C. (2001). The Systems of Innovation Approach and Innovation Policy: An account of the state of the art. In DRUID conference, Aalborg.

Endeavor & Enap (2020). Índice de cidades empreendedoras. Endeavor Brasil. Retrieved from https://repositorio.enap.gov.br/bitstream/1/6097/1/relatorio_ICE_2020.pdf

Engel, J. S., Berbegal-Mirabent, J., & Piqué, J. M. (2018). The renaissance of the city as a cluster of innovation. *Cogent Business & Management*, Vol. 5 No. 1, pp. 1-20.Engel, J. S., & del-Palacio, I. (2009). Global networks of clusters of innovation: Accelerating the innovation process. *Business horizons*, Vol. 52 *No.* 5, pp. 493-503.Etzkowitz, H., & Leydesdorff, L. (2000). The dynamics of innovation: from National Systems and "Mode 2" to a Triple Helix of university–industry–government relations. *Research Policy*, Vol. *29* No. 2, pp. 109-123.

Ennals, J. R., Gustavsen, B. (1999). Work Organization and Europe as a Development Coalition (Vol. 7). John Benjamins Publishing, Amsterdam, Netherlands.

Etzkowitz, H., & Leydesdorff, L. (1995). The Triple Helix - University-industry-government relations: A laboratory for knowledge based economic development. *EASST review*, *14*(1), 14-19. Retrieved from: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2480085

Etzkowitz, H., & Leydesdorff, L. (2000). The dynamics of innovation: from National Systems and “Mode 2” to a Triple Helix of university–industry–government relations. *Research Policy*, *29*(2), 109-123. Retrieved from: https://www.sciencedirect.com/science/article/abs/pii/S0048733399000554?via%3Dihub https://doi.org/10.1016/S0048-7333(99)00055-4

European Union (2016). Regional Innovation Ecosystems: Learning from the EU's Cities and Regions, available at: https://s3platform.jrc.ec.europa.eu/documents/20182/84453/Regional+Innovation+Ecosystems/48ab5553-489b-4c41-89b4-5c897e3ef066

FEE, 2017. Análise Socioeconômica da Cidade de Porto Alegre. Avaiable at https://www.fee.rs.gov.br/wp-content/uploads/2017/02/20170209relatorio-analisesocioecon0mica-da-cidade-de-porto-alegre-12017.pdf

Feldman, M.P., Audretsch, D.B. (1999). Innovation in cities: Science-based diversity, specialization and localized competition. European economic review 43(2), 409-429.

Fernandes, C.C., Oliveira Jr., M.d.M., Sbragia, R., and Borini, F.M. (2017), "Strategic assets in technology-based incubators in Brazil". *European Journal of Innovation Management*, *20*(1), 153-170. Retrieved from: https://www.emerald.com/insight/content/doi/10.1108/EJIM-04-2016-0043/full/html. https://doi.org/10.1108/EJIM-04-2016-0043

Ferraro, G. & Iovanella, A. (2015). Organizing Collaboration in Inter-organizational Innovation Networks, from Orchestration to Choreography. *International Journal of Engineering Business Management*, Vol. 7 No. 24, pp; 1-14.

Florida, R. (2002). The Rise of the Creative Class (Vol. 9). Basic Books, New York.

Florida, R. (2012). *The rise of the creative class - revisited: Revised and expanded*. New York: Basic Books.

Fung, V. K., Fung, W. K., & Wind, Y. J. R. (2007). *Competing in a flat world: building enterprises for a borderless world*. Pearson Prentice Hall, Upper Saddle River, NJ.

Gauchazh (2022). Marca de POA dá mais motivos para acreditar nos próximos 250 anos. Retrieved from: https://gauchazh.clicrbs.com.br/porto-alegre/noticia/2022/02/marca-de-poa-da-mais-motivos-para-acreditar-nos-proximos-250-anos-ckzzh7g29000p017cbkqhoa6c.html

Gault, F. (Ed.) (2013). Handbook of innovation indicators and measurement. Edward Elgar Publishing, United Kingdom.

GAZ (2021). Comitiva de Santa Cruz faz visita à Capital e projeta implantação de Berçário Tecnológico. Retrieved from: https://www.gaz.com.br/comitiva-de-santa-cruz-faz-visita-a-capital-e-projeta-implantacao-de-bercario-tecnologico/

Ghio, N., Guerini, M. & Rossi-Lamastra, C. (2019) The creation of high-tech ventures in entrepreneurial ecosystems: exploring the interactions among university knowledge, cooperative banks, and individual attitudes. *Small Business Economics* 52, 523–543. Retrieved from: https://link.springer.com/article/10.1007/s11187-017-9958-3 https://doi.org/10.1007/s11187-017-9958-3

Gil, A. C. (2002). Como elaborar projetos de pesquisa. São Paulo: Atlas.

Gomes, L. A. V., Chaparro, X. A. F., Facin, A. F. F., & Borini, F. M. (2021). Ecosystem management: Past achievements and future promises. *Technological Forecasting and Social Change*, *171*, 120950. https://doi.org/10.1016/j.techfore.2021.120950

Gomes, L.A.D.V., Facin, A.L.F., Salerno, M.S., Ikenami, R.K., (2018). Unpacking the innovation ecosystem construct: Evolution, gaps and trends. Technological Forecasting and Social Change 136(C), 30-48.

Governo do Estado do Rio Grande do Sul (2021). Conheça o Inova RS. Retrieved from: https://www.inova.rs.gov.br/conheca-inova-rs

Graham, R., 2013 Technology Innovation Ecosystem Benchmarking Study: Key findings from phase 1. Retrieved at https://www.rhgraham.org/RHG/Recent_projects_files/Benchamrking%20study%20-%20Phase%201%20summary%20.pdf

Greenwood, D.J., Levin, M. (2007). An epistemological foundation for action research. Introduction to action research, 55-76.

Gulati, R. (1998). Alliances and networks. *Strategic Management Journal*, *19*(4), 293-317. Retrieved from: https://onlinelibrary.wiley.com/doi/10.1002/(SICI)1097-0266(199804)19:4%3C293::AID-SMJ982%3E3.0.CO;2-M https://doi.org/10.1002/(SICI)1097-0266(199804)19:4<293::AID-SMJ982>3.0.CO;2-M

Hair, J., Babin, B., Money, A., & Samouel, P. (2003). *Fundamentos de métodos de pesquisa em administração*. Bookman Companhia Ed.

Hanson, D., Hitt, M. A., Ireland, R. D., & Hoskisson, R. E. (2017). *Strategic management:* Competitiveness and globalisation. Cengage AU.

Heaton, S., Siegel, D. S., & Teece, D. J. (2019). Universities and innovation ecosystems: a dynamic capabilities perspective. *Industrial and Corporate Change*, Vol. 28 No. 4, pp. 921-939.

Hill, G. (2014). Cycles of Action and Reflection. In: Coghlan, D., and Brydon-Miller, M. (Eds.). The SAGE encyclopedia of action research. Sage. https://doi.org/10.1023/A:1009989028605

Hitt, M. A., Ireland, R. D., & Hoskisson, R. E. (2017). *Strategic management: Concepts and cases: Competitiveness and globalization*. Cengage Learning.

Hurmelinna-Laukkanen, P., & Nätti, S. (2012). Network orchestration for knowledge mobility: the case of an international innovation community. *Journal of Business Market Management*, Vol. 5 No. 4, pp. 244-264.

Hurmelinna-Laukkanen, P., & Nätti, S. (2018). Orchestrator types, roles and capabilities – A framework for innovation networks. *Industrial Marketing Management*, Vol. 74, pp. 65–78.

Hurmelinna-Laukkanen, P., Möller, K., & Nätti, S. (2011), "Innovation orchestration matching network types and orchestration profiles", 27th Industrial Marketing and Purchasing Conference (IMP), Industrial Marketing and Purchasing Group (IMP), 1-3 September, Glasgow, avaiable at: https://www.impgroup.org/paper_view.php?viewPaper=7684

Iansiti, M., & Levien, R. (2004). Strategy as ecology. *Harvard Business Review*, *82*(3), 68-78.

IBGE – INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA (2019). Cidades: Porto Alegre. Retrieved at https://cidades.ibge.gov.br/brasil/rs/portoalegre/panorama

Inovação (2015). As dez cidades mais inovadoras do país.

Isenberg, D. (2013). Worthless, Impossible, and Stupid: How Contrarian Entrepreneurs Create and Capture Extraordinary Value. Harvard Business Review Press.

Isenberg, D.J. (2010). How to start an entrepreneurial revolution. *Harvard Business Review*, 88(6), 40-50.

Isenberg, D.J. (2011). The entrepreneurship ecosystem strategy as a new paradigm for economic policy: principles for cultivating entrepreneurship. Babson Entrepreneurship Ecosystem Project, Babson College, Babson Park: MA.

Jackson, D. J. (2011). What is an innovation ecosystem. *National Science Foundation*, *1*(2), 1-13.

Jacobides, M. G., Cennamo, C., & Gawer, A. (2018). Towards a theory of ecosystems. *Strategic Management Journal*, *39*(8), 2255-2276. Retrieved from:

https://onlinelibrary.wiley.com/doi/full/10.1002/smj.2904. https://doi.org/10.1002/smj.2904

Jarillo, J. C. (1988). On strategic networks. *Strategic Management Journal*, *9*(1), 31-41. Retrieved from: https://onlinelibrary.wiley.com/doi/abs/10.1002/smj.4250090104 https://doi.org/10.1002/smj.4250090104

Jones. T., M., Wicks, A.C., Freeman, R.E. (2002). Stakeholder Theory: The State of Art.

Jornal do Comércio (2022). *Mercado Paralelo acelera retomada do 4º Distrito*. Retrieved from: https://www.jornaldocomercio.com/_conteudo/ge2/noticias/2022/02/832179-mercado-paralelo-acelera-retomada-do-4-distrito.html

Karlsen, J., Larrea, M. (2016). Territorial Development and Action Research: Innovation Through Dialogue. Routledge, United Kingdom.

Kemmis, S., McTaggart, R. (1988). The Action Research Planner, 3rd Ed. Deakin University Press, Geelong, Victoria.

Kemmis, S., Mctaggart, R. (2007). Participatory Action Research. In Denzin, N. K.; Lincoln, Y. Handbook of qualitative research (3 Ed). Sage Publications, Inc., London.

Kleinsmann, M., Valkenburg, R., Sluijs, J. (2017). Capturing the value of design thinking in different innovation practices. International Journal of Design 11(2), 25-40.

Kotha, R., & George, G. (2012). Friends, family, or fools: Entrepreneur experience and its implications for equity distribution and resource mobilization. *Journal of Business Venturing*, *27*(5), 525-543. Retrieved from: https://www.sciencedirect.com/science/article/abs/pii/S0883902612000365?via%3Dihub https://doi.org/10.1016/j.jbusvent.2012.02.001

Kraaijenbrink, J., Spender, J. C., & Groen, A. J. (2010). The resource-based view: a review and assessment of its critiques. *Journal of Management*, *36*(1), 349-372. Retrieved from: https://journals.sagepub.com/doi/10.1177/0149206309350775 https://doi.org/10.1177/0149206309350775

Kruger, C., Cross, N. (2006). Solution driven versus problem driven design: strategies and outcomes. *Design Studies* 27(5), 527–548.

Kshetri, N. (2014). Developing successful entrepreneurial ecosystems. *Baltic Journal of Management*. Retrieved from: https://www.emerald.com/insight/content/doi/10.1108/BJM-09-2013-0146/full/html. https://doi.org/10.1108/BJM-09-2013-0146

Lambooy, J.G. (2006). Knowledge dissemination and innovation in urban regions: An evolutionary perspective. In Jarillo, F. J. Knowledge Cities (pp. 239-248). Routledge.

Lavie, D. (2006). The competitive advantage of interconnected firms: An extension of the resource-based view. *Academy of Management Review*, *31*(3), 638-658. Retrieved from: https://journals.aom.org/doi/10.5465/amr.2006.21318922. https://doi.org/10.5465/amr.2006.21318922

Lehmann, E.E., Seitz, N. (2017). Freedom and innovation: A country and state level analysis. The Journal of Technological Transfer 42**,** 1009–1029. https://doi.org/10.1007/s10961-016-9478-3

Lovallo, D., Maritan, C. A., and Wu, B (2022). Call for Papers for a Special Issue: Resource Allocation and Strategic Management. *Strategic Management Journal*.

Lumineau, F., & Oliveira, N. (2018). A pluralistic perspective to overcome major blind spots in research on interorganizational relationships. *Academy of Management Annals*, Vol. 12, pp. 440-465.

Majchrzak, A., Jarvenpaa, S. L., & Bagherzadeh, M. (2015). A review of interorganizational collaboration dynamics. *Journal of Management*, Vol. 41, pp. 1338-1360.

Makadok, R., Burton, R., & Barney, J. (2018). A practical guide for making theory contributions in strategic management. *Strategic Management Journal*, *39*(6), 1530-1545.

Martin, R., & Sunley, P. (2006). Path dependence and regional economic evolution. *Journal of economic geography*, *6*(4), 395-437.

Martins, B.V., Faccin, K., Motta, G.D.S., Bernardes, R., Balestrin, A. (2019). Evolução e tendências da agenda de pesquisa internacional em inovação. *Revista de Administração de Empresas*, 59(4), 293-307.

McDermott, G., Mudambi, R., & Parente, R. (2013). Strategic modularity and the architecture of multinational firm. *Global Strategy Journal*, Vol. 3 No.1, pp. 1–7.

McTaggart, R., Nixon, R., Kemmis, S. (2017). Critical Participatory Action Research. In The Palgrave international handbook of action research. ed. L. Rowell, C. D. Bruce, J. M. Shosh and M. M. Riel. Palgrave Macmillan, New York.

Menzel, M. P., & Fornahl, D. (2010). Cluster life cycles—dimensions and rationales of cluster evolution. *Industrial and Corporate Change*, Vol. 19 No. 1, pp. 205-238.

Mercan, B., Goktas, D. (2011). Components of innovation ecosystems: A cross-country study. International Research Journal of Finance and Economics 76(16), 102-112.

Miaskiewicz, T., Kozar, K.A. (2011). Personas and user-centered design: How can personas benefit product design processes?. Design Studies 32(5), 417-430.

Mintzberg, H. (1998) Covert leadership: Notes on managing professionals. *Harvard Business Review*. Vol. 76, pp. 140-148.

Molina-Azorín, J. F. (2014). Microfoundations of strategic management: Toward micro–macro research in the resource-based theory. *BRQ Business Research Quarterly*, *17*(2), 102-114. Retrieved from: https://www.sciencedirect.com/science/article/pii/S2340943614000206?via%3Dihub. https://doi.org/10.1016/j.brq.2014.01.001

Möller, K. & Halinen A. (2017). Managing business and innovation networks: From strategic nets to business fields and ecosystems. *Industrial Marketing Management*, Vol. 67, pp. 5-22

Moore, J. F. (1993). Predators and prey: a new ecology of competition. *Harvard Business Review*, Vol. 71 No. 3, pp. 75-86.

Morse, J. (2003). "Principles of mixed methods and multimethod research design." In Handbook of mixed methods in social and behavioral research, edited by A. Tashakkori and C. Teddlie, 189–208. Thousand Oaks, CA: SAGE Publications.

Mulas, Victor & Minges, Michael & Applebaum, Hallie. (2016). Boosting Tech Innovation: Ecosystems in Cities: A Framework for Growth and Sustainability of Urban Tech Innovation Ecosystems. *Innovations: Technology, Governance, Globalization*. 11. 98-125. 10.1162/inov_a_00251.

Muñoz, P., Kibler, E., Mandakovic, V., Amorós, J. E. (2020). Local entrepreneurial ecosystems as configural narratives: A new way of seeing and evaluating antecedents and outcomes. *Research Policy* 104065. doi:10.1016/j.respol.2020.104065

Nambisan S., & Sawhney, M. (2011). Orchestration Processes in Network-Centric Innovation: Evidence From the Field. *Academy of Management Perspectives,* Vol. 25, pp. 40–57.

Nicotra, M., Romano, M., Del Giudice, M., & Schillaci, C. E. (2018). The causal relation between entrepreneurial ecosystem and productive entrepreneurship: A measurement framework. *The Journal of Technology Transfer*, *43*(3), 640-673. Retrieved from: https://link.springer.com/article/10.1007%2Fs10961-017-9628-2. https://doi.org/10.1007/s10961-017-9628-2

Nilsen, E. R., & Gausdal, A. H. (2017). The Multifaceted Role of The Network Orchestrator: A Longitudinal Case Study. *International Journal of Innovation Management*, Vol. 21 No. 06.

OECD Publishing (2018). Oslo Manual 2018: Guidelines for collecting, reporting and using data on innovation. Organisation for Economic Co-operation and Development OECD.

Oliveira Jr., Moacir de Miranda, Cahen, Fernanda Ribeiro; Borini, Felipe Mendes (2019). Introduction. In: Startups and Innovation Ecosystems in Emerging Markets. Palgrave Macmillan, Cham, 2019a.

Ollila, S., Yström, A. (2020). Action research for innovation management: three benefits, three challenges, and three spaces. RandD Management. doi:10.1111/radm.12407

Organisation for Economic Co-operation and Development. (2005). *Oslo manual: Guidelines for collecting and interpreting innovation data* (No. 4). Publications de l'OCDE. Retrieved from: https://ec.europa.eu/eurostat/web/products-manuals-and-guidelines/-/OSLO

Østergaard, C.R., Dalum, B. (2012). Evolution of the geographical concentration pattern of the Danish IT sector: Christian R. Østergaard and Bent Dalum. In Bathelt, H., Feldman, M., and Kogler, D. F. (Eds.) Beyond Territory (pp. 96-118). Routledge, United Kingdom.

Pacto Alegre (2020). Conheça o Pacto. Retrieved from: https://pactoalegre.poa.br/o-que-e

Pattnaik, P. N., & Pandey, S. C. (2014). University spinoffs: what, why, and how?. *Technology Innovation Management Review*, *4*(12).

Pfeffer, J., Salancik, G.R. (1978). The External Control of Organizations. Harper and Row,

Pikkarainen, M., Ervasti, M., Hurmelinna-Laukkanen, P., & Nätti, S. (2017). Orchestration roles to facilitate networked innovation in a healthcare ecosystem. *Technology Innovation Management Review*, Vol. *7* No. 9, pp. 30-43.Piqué, J. M., Berbegal-Mirabent, J., & Etzkowitz, H. (2018). Triple helix and the evolution of ecosystems of innovation: the case of Silicon Valley. *Triple Helix*, Vol. *5* No. 1, pp. 1-21.

Pine, B.J., Gilmore, J.H. (1998). Welcome to the experience economy. *Harvard Business Review*, 76, 97-105.

Piqué, J. M., Miralles, F., & Berbegal-Mirabent, J. (2018). Application of the Triple Helix Model in the Creation and Evolution of Areas of Innovation. In *International Triple Helix Summit* (). Springer, Cham, pp. 223-244

Piqué, J.M., Miralles, F., & Berbegal-Mirabent, J. (2019). Areas of Innovation in Cities: The evolution of 22@Barcelona. *International Journal of Knowledge-Based Development*, *10*(1), 43-74.

Pisano, G.P., Verganti, R., 2008. Which kind of collaboration is right for you. *Harvard Business Review* 86(12), 78-86.

Powell, W.W., & S. Grodal (2005). Networks of Innovators, in Fagerberg, J., Mowery, D. C., & Nelson, R. R. (Ed.), *The Oxford Handbook of Innovation*, . Oxford University Press, Oxford, pp. 56-85

Prefeitura de Porto Alegre (2019). Retrieved from: http://www2.portoalegre.rs.gov.br/smf/default.php?p_secao=163

Presutti, M., Boari, C., & Majocchi, A. (2013). Inter-organizational geographical proximity and local startups' knowledge acquisition: a contingency approach. *Entrepreneurship & Regional Development*, Vol. 25, No. 5-6, pp. 446-467.

Priem, R. L., Butler, J. E., & Li, S. (2013). Toward reimagining strategy research: retrospection and prospection on the 2011 AMR decade award article. *Academy of Management Review*, *38*(4), 471-489.

Provan, K. G., & Kenis, P. (2008). Modes of network governance: Structure, management, and effectiveness. *Journal of Public Administration Research and Theory*, Vol. 18 No. 2, pp. 229-252.

Provan, K. G., & Milward, H. B. (2001). Do networks really work? A framework for evaluating public-sector organizational networks. *Public Administration Review*, Vol. 61 No. 4, pp. 414-423.Reynolds, E. B., & Uygun, Y. (2018). Strengthening advanced manufacturing innovation ecosystems: The case of Massachusetts. *Technological Forecasting and Social Change*, Vol. 136, pp. 178-191.

Provan, K. G., Fish, A., & Sydow, J. (2007). Interorganizational networks at the network level: A review of the empirical literature on whole networks. *Journal of Management*, *33*(3), 479-516. Retrieved from: https://journals.sagepub.com/doi/10.1177/0149206307302554. https://doi.org/10.1177/0149206307302554

Provan, K. G., Isett, K. R., & Milward, H. B. (2004). Cooperation and compromise: A network response to conflicting institutional pressures in community mental health. *Nonprofit and voluntary sector quarterly*, Vol. 33, No. 3, pp. 489-514.

Pruitt, J., Adlin, T. (2006). The persona lifecycle: Keeping people in mind throughout product design. Morgan Kaufmann, San Francisco.

Rabelo, R. J., & Bernus, P. (2015). A holistic model of building innovation ecosystems. *IFAC-PapersOnLine*, *48*(3), 2250-2257. Retrieved from: https://www.sciencedirect.com/science/article/pii/S240589631500662X?via%3Dihub. https://doi.org/10.1016/j.ifacol.2015.06.423

Reason, P., Bradbury, H. (Eds.) (2001). Handbook of Action Research: Participative Inquiry and Practice. Sage.

Reynolds, E. B., & Uygun, Y. (2018). Strengthening advanced manufacturing innovation ecosystems: The case of Massachusetts. *Technological Forecasting and Social Change*, *136*, 178-191. Retrieved from: https://www.sciencedirect.com/science/article/abs/pii/S0040162517307680?via%3Dihub. https://doi.org/10.1016/j.techfore.2017.06.003

Reypens, C., Lievens, A., & Blazevic, V. (2021). Hybrid Orchestration in Multi-stakeholder Innovation Networks: Practices of mobilizing multiple, diverse stakeholders across organizational boundaries. *Organization Studies*, Vol. 42 No. 1, pp. 61–83.

Rietveld, J., & Schilling, M. A. (2021). Platform competition: A systematic and interdisciplinary review of the literature. *Journal of Management*, *47*(6), 1528-1563.

Ritala P., Armila L., & Blomqvist K. (2009) Innovation orchestration capability: defining the organizational and individual level determinants. *International Journal of Innovation Management*. Vol. 13 No. 4, pp.569-591.

Ritala, P., Hurmelinna-Laukkanen, P., & Nätti, S. (2012). Coordination in innovation-generating business networks – the case of Finnish Mobile TV development. *Journal of Business & Industrial Marketing,* No. 27, pp. 324-334.

Ritter, T., Wilkinson, I. F., & Johnston, W. J. (2004). Managing in complex business networks. *Industrial Marketing Management,* Vol. 33 No. 3, pp. 175-183.

Roundy, Philip T. (2018). Rust belt or revitalization: competing narratives in entrepreneurial ecosystems. Management Research Review, https://doi.org/10.1108/MRR-01-2018-0019

Sampieri, R. H., Collado, C. F., & Lucio, M. del P. B. (2013). Metodologia de Pesquisa. Porto Alegre: Penso.

Santos, C. A. F., Valle, V. Z., Netto, C. O., & Zen, A. C. (2021). Análise do Desenvolvimento do Ecossistema Regional de Inovação de Pelotas (RS): estudo de caso em uma cidade de médio porte. *In Anais do XXIV Semead*.

Santos, D. A. G. dos, Zen, A. C., & Bittencourt, B. A. (2021). From governance to choreography: coordination of innovation ecosystems. *Innovation & Management Review*.

Santos, D. A. G. dos; Zen, A. C. (2020). Orquestração de Atores e Recursos em Ecossistemas de Inovação. In: XLIV Encontro da Anpad - EnANPAD 2020.

Santos, D. A. G. dos; Zen, A. C.; Faccin, K. (2020). Mapping, Analyzing, and Designing Innovation Ecosystems in Cities: an Action Research Approach. In: XXIII Seminários em Administração - Semead 2020. São Paulo.

Santos, D.A.G. dos (2017). A influência do ecossistema de empreendedorismo no comportamento dos empreendedores. Masters Thesis.

Sarasvathy, S. D. (2001). Causation and effectuation: Toward a theoretical shift from economic inevitability to entrepreneurial contingency. *Academy of management Review*, *26*(2), 243-263.

Saxenian, A., 1994. *Regional advantage*: Culture and competition in Silicon Valley and Route, 128.

Scaringella, L., & Radziwon, A. (2018). Innovation, entrepreneurial, knowledge, and business ecosystems: Old wine in new bottles?. *Technological Forecasting and Social Change*, *136*, 59-87.

Schaeffer, P., Fischer, B., Queiroz, S.R., 2018. Innovation Ecosystems in Brazil: Research Universities as Drivers of Competitiveness. Paper presented at Simpósio de Gestão da Inovação Tecnológica 2018, Porto Alegre.

Schaffers, H., Komninos, N., Pallot, M., Trousse, B., Nilsson, M., & Oliveira, A. (2011, May). Smart cities and the future internet: Towards cooperation frameworks for open innovation. In *The future internet assembly* (pp. 431-446). Springer, Berlin, Heidelberg.

Schumpeter, J. A. (1982). *The theory of economic development: An inquiry into profits, capital, credit, interest, and the business cycle (1912/1934)*. New Jersey: Transaction Publishers.

Schumpeter, J.A. (1985). O fenômeno fundamental do desenvolvimento econômico. A teoria do desenvolvimento econômico. Rio de Janeiro: Nova Cultural.

Schwab, K., & Zahidi, S. (2020). Global competitiveness report: special edition 2020. World Economic Forum.

Shaw, D. R., & Allen, T. (2018). Studying innovation ecosystems using ecology theory. *Technological Forecasting and Social Change*, *136*, 88-102. Retrieved from: https://www.sciencedirect.com/science/article/abs/pii/S0040162516307880?via%3Dihub. https://doi.org/10.1016/j.techfore.2016.11.030

Shi, Q. and Shen, L. (2021), "Orchestration capability: a bibliometric analysis", *Kybernetes*, Vol. ahead-of-print No. ahead-of-print. https://doi.org/10.1108/K-05-2021-0386

Shipilov, A., & Gawer, A. (2020). Integrating research on interorganizational networks and ecosystems. *Academy of Management Annals*, *14*(1), 92-121. Retrieved from: https://journals.aom.org/doi/10.5465/annals.2018.0121. https://doi.org/10.5465/annals.2018.0121

Sirmon, D. G., Hitt, M. A., & Ireland, R. D. (2007). Managing firm resources in dynamic environments to create value: Looking inside the black box. *Academy of Management Review*, *32*(1), 273-292. Retrieved from: https://journals.aom.org/doi/10.5465/amr.2007.23466005. https://doi.org/10.5465/amr.2007.23466005

Sirmon, D. G., Hitt, M. A., Ireland, R. D., & Gilbert, B. A. (2011). Resource orchestration to create competitive advantage: Breadth, depth, and life cycle effects. *Journal of Management*, *37*(5), 1390-1412. Retrieved from: https://journals.sagepub.com/doi/10.1177/0149206310385695. https://doi.org/10.1177/0149206310385695

Sotarauta, M. Pulkkinen, R. (2011). Institutional entrepreneurship for knowledge regions: In search of a fresh set of questions for regional innovation studies. Environment and Planning C: Government and Policy 29(1), 96-112.

Spigel, B. (2017). The relational organization of entrepreneurial ecosystems. *Entrepreneurship Theory and Practice*, *41*(1), 49-72. Retrieved from: https://journals.sagepub.com/doi/10.1111/etap.12167. https://doi.org/10.1111/etap.12167

Spigel, B., & Harrison, R. (2018). Toward a process theory of entrepreneurial ecosystems. *Strategic Entrepreneurship Journal*, Vol. 12 No. 1, pp. 151-168.

Stam, E. (2015). Entrepreneurial ecosystems and regional policy: a sympathetic critique. *European Planning Studies*, *23*(9), 1759-1769. Retrieved from: https://www.tandfonline.com/doi/full/10.1080/09654313.2015.1061484. https://doi.org/10.1080/09654313.2015.1061484

Stam, E., & Spigel, B. (2017). *Entrepreneurial ecosystems* (Vol. 16, No. 13, pp. 1-15). USE Discussion paper series.

Startup Base (2021). Estatísticas. Retrieved from: https://startupbase.com.br/home/stats

Steinbruch, F. K., da Silva Nascimento, L., & de Menezes, D. C. (2021). The role of trust in innovation ecosystems. *Journal of Business & Industrial Marketing*.

Suominen, A., Seppänen, M., Dedehayir, O. (2019). A bibliometric review on innovation systems and ecosystems: A research agenda. European Journal of Innovation Management

22(2), 335-360. Retrieved from: https://www.emerald.com/insight/content/doi/10.1108/EJIM-12-2017-0188/full/html. https://doi.org/10.1108/EJIM-12-2017-0188

Talmar, M., Walrave, B., Podoynitsyna, K.S., Holmström, J., Romme, A.G.L. (2018). Mapping, analyzing and designing innovation ecosystems: The Ecosystem Pie Model. Long Range Planning 53(4), 101850.

Thomas, E., Faccin, K., & Asheim, B. T. (2020). Universities as orchestrators of the development of regional innovation ecosystems in emerging economies. Growth and Change.

Thomas, L. D., & Autio, E. (2020). Innovation Ecosystems in Management: An Organizing Typology. In *Oxford Research Encyclopedia of Business and Management*. Retrieved from: https://oxfordre.com/business/view/10.1093/acrefore/9780190224851.001.0001/acrefore-9780190224851-e-203. https://doi.org/10.1093/acrefore/9780190224851.013.203

Thomas, L.D., Sharapov, D., Autio, E. (2018). Linking entrepreneurial and innovation ecosystems: The case of AppCampus. In Entrepreneurial ecosystems and the diffusion of startups. Edward Elgar Publishing, United Kingdom.

Tödtling, F., & Trippl, M. (2005). One size fits all?: Towards a differentiated regional innovation policy approach. *Research policy*, *34*(8), 1203-1219.

Townsend, A. (2014). Collaborative action research. In The SAGE encyclopedia of action research. ed. D. Coghlan and M. Brydon-Miller. Sage.

UFRGS – Universidade Federal do Rio Grande do Sul (2018). *Formada aliança para transformar Porto Alegre em referência mundial em inovação*. Retrieved from: http://www.ufrgs.br/ufrgs/noticias/formada-alianca-para-transformar-porto-alegre-em-referencia-mundial-em-inovacao

uMov.me (2021). Dito Efeito. Retrieved from: https://www.umov.me/category/dito-efeito/

UNIDO (2019). Bridge for Cities 4.0. Retrieved from: https://www.unido.org/sites/default/files/files/2019-09/Bridge4Cities%20Issue%20Paper_Final.pdf

Urbancova, H. (2013). Competitive advantage achievement through innovation and knowledge. Journal of competitiveness 5(1), 82-96.

Uzzi, B. (1996). The sources and consequences of embeddedness for the economic performance of organizations: The network effect. *American Sociological Review*, 674-698. Retrieved from: https://www.jstor.org/stable/2096399?origin=crossref&seq=1#metadata_info_tab_contents. https://doi.org/10.2307/2096399

Valkokari, K., Seppänen, M., Mäntylä, M., & Jylhä-Ollila, S. (2017). Orchestrating innovation ecosystems: A qualitative analysis of ecosystem positioning strategies. *Technology Innovation Management Review*, *7*(3). Retrieved from: https://timreview.ca/sites/default/files/article_PDF/Valkokari_et_al_TIMReview_March2017.pdf

Verganti, R., Dell'Era, C. (2014). Design-driven innovation: Meaning as a source of innovation. In: The Oxford Handbook of Innovation Management. ed. M. Dodgson, D. Gann and F. Phillips. Oxford University Press, Oxford.

Waleczek, P., Zehren, T., & Flatten, T. C. (2018). Start-up financing: How founders finance their ventures' early stage. *Managerial and Decision Economics*, *39*(5), 535-549. Retrieved from: https://onlinelibrary.wiley.com/doi/abs/10.1002/mde.2925. https://doi.org/10.1002/mde.2925

Walrave, B., Talmar, M., Podoynitsyna, K. S., Romme, A. G. L., & Verbong, G. P. (2018). A multi-level perspective on innovation ecosystems for path-breaking innovation. *Technological Forecasting and Social Change*, *136*, 103-113. Retrieved from: https://www.sciencedirect.com/science/article/abs/pii/S0040162517304997?via%3Dihub. https://doi.org/10.1016/j.techfore.2017.04.011

Wernerfelt, B. (1984). A resource-based view of the firm. *Strategic Management Journal*, *5*(2), 171-180. Retrieved from: https://onlinelibrary.wiley.com/doi/abs/10.1002/smj.4250050207. https://doi.org/10.1002/smj.4250050207

WIPO (2021). Global Innovation Index 2021: Tracking Innovation through the COVID-19 Crisis. Geneva: World Intellectual Property Organization

World Bank (2020a). *Doing Business 2020*. Retrieved from: https://openknowledge.worldbank.org/bitstream/handle/10986/32436/9781464814402.pdf

World Bank (2020b). *Urban Development*: Overview. Retrieved from: https://www.worldbank.org/en/topic/urbandevelopment/overview#1

World Economic Forum, 2013. Entrepreneurial ecosystems around the globe and early-stage company growth dynamics: the entrepreneur's perspective. Avaiable at http://www3.weforum.org/docs/WEF_EntrepreneurialEcosystems_Report_2013.pdf

Wurth, B., Stam, E., & Spigel, B. (2021). Toward an entrepreneurial ecosystem research program. *Entrepreneurship Theory and Practice*, 1042258721998948.

Yahoo (2022). *South Summit, um dos maiores eventos de inovação, chega pela 1ª vez ao Brasil*. Retrieved from: https://br.noticias.yahoo.com/south-summit-um-dos-maiores-141200457.html

Yawson, R. M. (2009). The ecological system of innovation: A new architectural framework for a functional evidence-based platform for science and innovation policy. In *The Future of Innovation Proceedings of the XXIV ISPIM 2009 Conference, Vienna, Austria*. Retrieved from: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1417676

Young, D. (1982) Organization and Orchestra: Lesson from the Pit. *Journal of Policy Analysis and Management*, Vol. 1 No. 2 Winter, pp. 264-267.

Zahra, S. A., Wright, M., & Abdelgawad, S. G. (2014). Contextualization and the advancement of entrepreneurship research. *International Small Business Journal*, *32*(5), 479-500. Retrieved from: https://journals.sagepub.com/doi/10.1177/0266242613519807. https://doi.org/10.1177/0266242613519807

Zen, A. C., & Fracasso, E. M. (2012). Recursos, competências e capacidade de inovação: um estudo de múltiplos casos na indústria eletro-eletrônica no Rio Grande do Sul. *RAI Revista de Administração e Inovação*, *9*(4), 177-201. Retrieved from: http://www.revistas.usp.br/rai/article/view/79294. https://doi.org/10.5773/rai.v9i4.877

Zen, A. C., Santos, D. A. G., Faccin, K., & Gonçalves, L. F. (2019). *Mapeamento do Ecossistema de Inovação: Percepções e Desafios.* Retrieved at: https://pactoalegre.poa.br/downloads

Zeng, J., Tavalaei, M. M., & Khan, Z. (2021). Sharing economy platform firms and their resource orchestration approaches. *Journal of Business Research*, *136*, 451-465.