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**THE DYNAMICS OF OPEN INNOVATION IN THE INNOVATION ECOSYSTEMS'
LIFECYCLE**

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LIFECYCLE**

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ABSTRACT

Organizations leverage innovation to stay competitive amidst rising competition and fast technological changes. Innovation now extends beyond organizational borders through collaborations, sparking discussions among academia, governments, and entrepreneurs. The concept of open innovation, introduced by Chesbrough (2003), is a prominent theoretical framework exploring these multi-actor collaborations, but has frequently been used at the level of the firm, lacking further exploration in other level of analysis to unravel contingencies and the dynamics of open innovation. This dissertation aims to analyze how open innovation influences the emergence, development, and performance of regional innovation ecosystems. We have identified three main theoretical gaps that relates open innovation and regional innovation ecosystems. The first gap is related to how open innovation and innovation ecosystems approaches are interconnected using a life cycle perspective to comprehend the different stages of the ecosystem. The second gap refers to the mechanisms of open innovation employed in regional innovation ecosystems. Lastly, the third gap addressed in this dissertation explores open innovation in the context of emerging economies, which has been under investigated in the open innovation approach since its conception. Three studies were developed to fill such gaps. The first paper is a theoretical essay that analyzes the role and the mechanisms of open innovation throughout the life cycle of innovation ecosystems. We propose an integration between open innovation and innovation ecosystems and presented a set of components to assess open innovation at different stages of the innovation ecosystem's life cycle. The second paper adopts a qualitative case study in the Serra Gaúcha and aims to evaluate the role of open innovation mechanisms within the regional innovation ecosystem. The paper highlights the importance of open innovation in the development of regional innovation ecosystems. We found that open innovation mechanisms are crucial in the early stages of an innovation ecosystem, facilitating the creation of a network identity and alignment of strategic objectives and contributing for a change in the level of openness among the actors participating in the ecosystem over time. The third paper presents a quantitative study conducted within the regional innovation ecosystem of Rio Grande do Sul. Our results revealed that openness exerts a positive and significant impact on ecosystem performance. This suggests that promoting collaboration and utilizing knowledge exchange within the ecosystem contribute to enhancing firms' level of openness. Our findings also indicate a favorable correlation between openness and the abilities to acquire and exploit. Finally, the research underscores the importance of fostering a culture of openness and collaboration within regional innovation ecosystems. By adopting open innovation mechanisms and promoting knowledge exchange, strategic alignment, and increased engagement among ecosystem actors, open innovation can serve as a catalyst for driving innovation, economic growth, and prosperity within the region.

Keywords: open innovation; openness; regional innovation ecosystem; life cycle; performance.

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1. INTRODUCTION

Organizations rely on their innovation capabilities to sustain a competitive advantage in a context of increasing competition and rapid technological transformation (Kraus et al., 2020). Consequently, innovation, which was traditionally developed mainly within the organization, has increasingly surpassed the boundaries of the firm and is now being pursued through collaboration with different actors. It has generated implications that are being discussed in academia, by governments, and among entrepreneurs. Among the theoretical approaches that explore these collaborative connections with multiple actors, we highlight the debate on open innovation, a term coined by Chesbrough (2003).

Chesbrough and Bogers (2014, p. 17) define open innovation as "a distributed innovation process based on purposively managed knowledge flows across organizational boundaries". In general, open innovation assumes that ideas can originate both internally and externally to the firm, and they can be brought to the market either by the company itself or through external ventures. The open innovation approach fosters new avenues for innovation by treating externally generated ideas with the same importance as internal ideas (Chesbrough, 2003; Bogers et al., 2018). This inclusive perspective allows for the exploration of novel forms of innovation.

Open innovation encompasses important characteristics such as the ability to collaborate with talented individuals both within and outside the organization, the potential to profit from research that did not necessarily was originated internally, and the ability to blend internal and external ideas to achieve desired outcomes (Freeman & Soete, 2008). Furthermore, there are additional benefits that can incentivize organizations to adopt the open innovation paradigm within their innovation processes, including cost reduction in technology development, economies of scale, and risk mitigation when entering new markets (Tidd & Bessant, 2009).

Extensive research has focused on the microfoundations of open innovation at the firm level over the years (Bogers et al., 2017). Consequently, the literature has identified various forms of open innovation (Gassmann & Enkel, 2004), explored the benefits and costs associated with different levels of openness (Dahlander & Gann, 2010), and investigated the phenomenon across different industries (Chesbrough & Crowther, 2006) and varying technological intensities (Oduro, 2019). Studies have examined open innovation in both large enterprises (Chesbrough & Brunswicker, 2014) and small businesses (Lee et al., 2010), with a primary focus on the contingent factors of open innovation that influence firm strategy, competitive advantage, and its business model.

In this context, the literature also reveals the complexity of adopting the open innovation paradigm. Many companies face challenges when implementing open innovation due to both organizational and individual factors (Bogers et al., 2019). As a result, when firms undertake open innovation initiatives, numerous managerial aspects are influenced by this shift and require careful reconsideration. For instance, the governance structure of the organization needs to be reevaluated. In the open innovation process, instead of pursuing a generalized innovation strategy, firms must determine the most suitable governance approach depending on the problem to be solved (Pisano & Verganti, 2008). Consequently, as each governance mode provides access to different communication channels, incentives, and property rights (Felin & Zenger, 2014), managing open innovation becomes a more intricate task.

Although the concept of open innovation is intrinsically connected to interorganizational relationships, it was mostly explored on how the firm manage its resources in an open context instead of analyzing the interorganizational context and how it may affect the adoption of open innovation. Thus, the current debate surrounding open innovation encompasses various levels of analysis (Vanhaverbeke et al., 2014; Bogers et al., 2017; Bogers et al., 2018) as an opportunity to unravel the contingencies of open innovation and create a deeply understanding about the phenomenon. This includes exploration at the intraorganizational level, where challenges at the individual level and coping strategies for open innovation are examined (e.g., Salter et al., 2015). Additionally, open innovation has been explored in interorganizational, sectoral, and even regional contexts, where contingencies, network elements, and governance factors are scrutinized (Bogers et al., 2017).

At the interorganizational level of analysis, the focus is organizations within networks, industries, and sectors. Therefore, open innovation is practiced and embedded within a set of political and economic institutions, including regulation, intellectual property laws, capital markets, and the industrial fabric (West, Vanhaverbeke, & Chesbrough, 2006). Thus, it is necessary for the institutional context to be appropriately configured to be suitable and supportive of the integration and commercialization of external knowledge. In other words, the implementation of open innovation depends not only on the willingness of a firm to cooperate and share ideas beyond its organizational boundaries, but also on systemic factors, including incentives and obstacles established by the regulatory framework within which the firm operates (Bogers et al., 2019).

In this dissertation, our aim is to address the interorganizational level of open innovation within the context of regional innovation ecosystems. Innovation ecosystems have gained prominence in academia as a trend when considering the characteristics of innovation networks

and the systemic nature of innovation, which has the potential to generate economic and social development through the construction of a complex network connecting various actors to produce cycles of innovation (Giannopoulos & Munro, 2019). However, literature has highlighted ambiguous contributions in this field, mainly due to inconsistent use of the term "innovation ecosystems" (Oh, Phillips, Park & Lee, 2016; Ritala & Almpanopoulou, 2017; Baiyere, 2018). Therefore, Ritala and Almpanopoulou (2017) argue that the concept of innovation ecosystems should be employed for systems that focus on innovative activities as their main objective, involving the logic of interdependence among actors within a spatial context and considering the inherent coevolution of actors. Additionally, Jacobides, Veloso, and Wolter (2014) emphasize that ecosystems differ from other interorganizational networks in that they are not hierarchically managed, but rather each actor pursues their own objectives within the network, generating competitive advantage for the ecosystem.

The concept of innovation ecosystem originates from Moore's (1993) business ecosystems, but it was first introduced by Adner (2006) that poses the innovation ecosystem as the core of firms' growth strategies. Since then, the concept of innovation ecosystem has evolved dividing into non-spatial ecosystems focusing on a focal firm or platform and the spatial perspective emphasizing the geographic delimitation and coordination mechanisms (Zen et al., 2023).

Regional innovation ecosystems rely on territorial approaches that consider regions and their external factors as essential elements for their emergence and sustainability (Dedehayir et al., 2018; Cantner et al., 2021). We understand regional innovation ecosystems as open and dynamic networks of interdependent actors (Jacobides et al., 2014; Suominen et al., 2019), including universities, industries, government, and civil society (Carayannis and Campbell, 2009), that co-evolve through waves of cooperation and conflict (Valkokari et al., 2017) creating and capturing value from collaboration (Radziwon et al., 2017) in a given territory.

Both open innovation and innovation ecosystems have gained prominence in the field of innovation and have been closely related, particularly in recent years (Yaghmaie & Vanhaverbeke, 2020). The increasing adoption of open innovation within companies is also reflected in the growing number of publications on the subject. However, open innovation has primarily been studied at the firm level, while other levels of analysis can deepen our understanding of this phenomenon, revealing new relevant processes and contingencies surrounding open innovation (West & Bogers, 2014; Vanhaverbeke, Chesbrough & West, 2014). In this regard, the literature has also emphasized the relevance of interrelated networks of companies as determinants of successful innovation capability (Shan et al., 1994;

Chesbrough, 2003; van de Vrande et al., 2009). Gao et al. (2020) presents a new route for open innovation by showing that existing studies mainly focus on interorganizational collaborations with a single cooperating partner, thus highlighting new research possibilities for open innovation with multiple partners working together. This gap in the literature on open innovation paves the way for discussions on interorganizational networks that go beyond dyadic collaborations (West et al., 2014; Öberg & Alexander, 2019).

Therefore, recent studies have been addressed open innovation and innovation ecosystems (Radziwon, Bogers & Bilberg, 2017; Radziwon & Bogers, 2019; Öberg & Alexander, 2019; Alam et al., 2022) by analyzing the contingencies of open innovation in innovation ecosystems. Among the findings, Radziwon et al. (2017) identify drivers and challenges for value creation in small and medium-sized manufacturing enterprises (SMEs) that have implemented open innovation practices within a regional innovation ecosystem. Benz and Seebacher (2018) propose a research agenda that encompasses different levels of analysis for open innovation in ecosystems. Öberg and Alexander (2019) establish connections between open innovation and innovation ecosystems by identifying knowledge transfer within open innovation practices at the ecosystem level of analysis. Ferrari, Santoro, and Pellicelli (2020) analyze the barriers and challenges faced by governments in implementing open innovation to foster the creation of entrepreneurship and innovation ecosystems.

However, only a few publications on innovation ecosystems have explicitly connected them to open innovation, leaving many unanswered questions (Yaghmaie & Vanhaverbeke, 2020). Therefore, the authors indicate that there are three elements in open innovation that need to be taken into consideration to understand innovation ecosystems through the lens of open innovation: (i) the impact of the level of analysis needs to be altered, (ii) specific attention to the different actors and their roles in the ecosystem, and (iii) consideration of new forms of role management, such as orchestrators, instigators, and implementers in the ecosystem.

As an evolutionary approach, innovation ecosystems can be analyzed through different stages of maturity in their life cycle. By using a life cycle approach (Moore, 1993; Heaton et al., 2019; Piqué et al., 2019), studies have identified stages of maturity based on stakeholder engagement, governance model, innovation outcomes, and trust. In this research, we adopt Heaton et al.'s (2019) life-cycle approach consisting of three stages. The initial stage involves a small number of actors, limited interactions, and a weak ecosystem identity. The lead actor plays a crucial role in initiating connections, orchestrating resources, and establishing common goals for value creation within the network. In the development stage, supporting agents and organizations actively participate, and communication channels and flows are established. The

renewal stage signifies a shift towards new domains when established sectors stagnate and patent activity needs redirection.

In this line, we highlight that the assessment of the evolution of regional innovation ecosystems remains underexplored in the literature, but a few studies address that the ecosystem performance relies on several factors, such as the orchestration of the ecosystem, the level of collaboration between actors, the quality of the human capital, and the quality of the infrastructure (Scaringella & Radziwon, 2018). Bittencourt et al. (2020) indicate that the lack of alignment among actors could have a negative influence on the development of innovation ecosystems. Alvedalen and Boschma (2017) point out that the local infrastructure, specialized services, and trust levels among actors that constitute the ecosystem have a significant impact on the region's innovative activity.

While the literature on innovation management understands that the approach of open innovation can serve as a framework that shapes actions in the context of an innovation ecosystem (Wallner & Menrad, 2011; Vlasisavljevic, Medina, & Van Looy, 2020), emphasizing the importance of collaboration and the level of openness of actors within an innovation ecosystem, there is still room for exploring the impact of open innovation in the configurations of innovation ecosystems (Bogers et al., 2017). Also from this perspective, Yaghmaie & Vanhaverbeke (2020) emphasize that there is a lack of information about open innovation mechanisms regarding the level of analysis of ecosystems, which can result in potential challenges for the implementation of open innovation-based management.

Therefore, aiming to advance the literature on the connections between open innovation and innovation ecosystems, the guiding question of this project is: **how does open innovation influence the emergence, development, and performance of regional innovation ecosystems?** In order to analyze how open innovation can contribute to the development of innovation ecosystems, the life cycle approach is used to understand the relationship between the concepts in a comprehensive manner, encompassing the dynamism and coevolution that are intrinsic characteristics of innovation ecosystems.

1.1 Objectives

This dissertation seeks to analyze how open innovation influences the emergence, development, and performance of regional innovation ecosystems.

The specific objectives are:

- a) To analyze the role of open innovation in different stages of the development of regional innovation ecosystems.
- b) To map the mechanisms of open innovation in different stages of the regional innovation ecosystem life cycle.
- c) To identify the influence of openness level in the performance of regional innovation ecosystems.

1.2 Potential contributions

After two decades since Chesbrough's seminal work (2003) that defined the term open innovation, despite the efforts of various authors to uncover different processes and mechanisms of open innovation at different levels of analysis, there are still many aspects that need to be understood more deeply (West & Bogers, 2014; Huizingh, 2011; Dahlander & Gann, 2010; Gao et al., 2020). Considering this, several studies in the field of open innovation have drawn attention to areas for advancement in literature (Bogers et al., 2017; Dahlander, Gann & Wallin, 2021), particularly focusing on levels of analysis beyond the firm level.

Therefore, this dissertation addresses these raised issues and aims to fill the gaps in the open innovation literature that suggests research on interorganizational networks with multiple heterogeneous actors involved in the open innovation process (Bogers et al., 2017) and innovation ecosystems that seek to understand the open innovation mechanisms that enable sustainable network development (Yaghmaie & Vanhaverbeke, 2020) through the life cycle perspective in order to highlight the different open innovation mechanisms present in the various stages of an innovation ecosystem.

The first gap this dissertation explores is the convergence of open innovation and innovation ecosystems using the life cycle framework. As a result, we understand how open innovation can shape the development of innovation ecosystems, starting from their emerging stage to maturity. While using the context of ecosystems for advancing open innovation approach is growing, it remains relatively uncommon in the literature (Bogers et al., 2017), presenting a unique opportunity to shed light on the role of open innovation within complex networks of actors, where cooperation and competition intertwine to foster innovation cycles.

Moreover, we aim to highlight the dynamicity and the coevolution aspects of innovation ecosystems by employing the life cycle perspective to illustrate the role of open innovation in each of their stages. Despite the central importance of the dynamic and coevolutionary nature of actors over time, only a few authors have explored innovation ecosystems from a life cycle

perspective (Moore, 1993; Piqué, Miralles, & Berbegal-Mirabent, 2019; Heaton et al., 2019; Bittencourt, Zen, & Santos, 2020; Santos, Zen, & Bittencourt, 2021).

The second gap we explore is related to the mechanisms of open innovation used in regional innovation ecosystems. The literature indicates that there is insufficient information about open innovation mechanisms at the ecosystem level, which could potentially hinder the implementation of open innovation-based management (Yaghmaie and Vanhaverbeke, 2020). Only a few studies are currently addressing open innovation mechanisms at the network level (Ogink et al., 2023), which brings forth several challenges in successfully implementing open innovation activities within ecosystems (Yaghmaie and Vanhaverbeke, 2020). Therefore, a study that investigates the mechanisms of open innovation in ecosystems is appropriate to generate insights on how open innovation strategies applied by different actors within a regional innovation ecosystem can foster regional development. In addition, we aim to contribute on how the innovation might impact the performance of regional innovation ecosystems over time.

The third gap that the dissertation addresses is related to the context of emerging economies, which has been relatively underexplored in the literature on open innovation. The focus of research in this area has predominantly been on industrialized economies, leading to a lack of attention towards understanding the open innovation phenomenon within emerging economy contexts (Bogers et al., 2019). We identified few studies have investigated how open innovation is implemented in emerging economies, such as Brazil (Melo et al., 2020), India (Kafouros and Forsans, 2012; Naqshbandi et al., 2019), and China (Torres et al., 2020).

1.3 Methodological Aspects

In our study, we conduct mixed-method research to analyze how open innovation influences the emergence, development, and performance of regional innovation ecosystems. With this perspective in mind, we empirically examined how these two constructs are interconnected, considering the specific context of the Serra Gaúcha region and the state of Rio Grande do Sul, characterized by high competitiveness and low trust among actors when it comes to collaborating for innovation.

In the first paper, we carried out a theoretical essay and delved into the connection between open innovation and ecosystems. By bringing together these two approaches, the goal was to develop a theoretical framework that offers a dynamic perspective on the role of open innovation in the life cycle of innovation ecosystems and to lay the foundation for the discussion leading to the development of the dissertation.

For the second and third papers, the research was conducted in Brazil, more specifically through a qualitative case study in the Serra Gaúcha regional innovation ecosystem and a survey conducted in the state of Rio Grande do Sul.

Therefore, it is important to highlight the Brazilian context, since it is the largest country in South America in terms of both population and territory. Brazil holds significant representation within the Latin American context, ranking as the ninth-largest economy globally, according to the International Monetary Fund (2023) and the first position in the Innovation Economy Latin America and the Caribbean (WIPO, 2023). Over the past few years, Brazil has made strides in the Global Innovation Index (GII), climbing from 62nd place in 2020 to reach the 49th spot in 2023. However, despite these improvements, Brazil still possesses substantial underexplored potential for enhancing its innovation landscape. Notably, in 2021, Brazil secured the 14th position for scientific output. Nonetheless, it's crucial to acknowledge that Brazil's investment in research and development (R&D) only amounted to 1.14 percent of its GDP in 2020, whereas leading economies typically allocate more than 3 percent of their GDP to R&D (WIPO, 2023).

Emerging economies like Brazil offers a rich context to explore the contingencies of open innovation approach, since collaborative innovation can offer frugal solutions for expensive and complex problems. In addition, the Brazilian context faces a low level of openness for collaborating with others (Bogers et al., 2019), which impacts the innovation outcomes due to different available knowledge options (Kafouros and Forsans, 2012) and team capabilities (Redding and Witt, 2007).

Given the Brazilian scenario, the second paper is a case study conducted in the Serra Gaúcha region, in the south of Brazil. This study utilizes a qualitative approach, incorporating both primary and secondary data, to examine the mechanisms of open innovation within the life cycle of a regional innovation ecosystem. Following Yin's (2009) case study methodology, the research analyzes a diverse array of stakeholders, including firms, universities, government, and startups, comprising the ecosystem. Data collection occurred between April 2022 and February 2023, involving in-depth interviews with various stakeholders. A semi-structured script, validated by experts, guided the interviews, recorded and transcribed for analysis. Nineteen interviews, averaging 47 minutes each, constituted the primary data set. Additionally, secondary data from public databases, annual reports, archives, and other sources were collected to ensure reliability through triangulation across different data sources. The comprehensive approach provides insights into the dynamics of open innovation in the examined innovation ecosystem.

The selection of the regional innovation ecosystem in Serra Gaúcha was based on the region's significant role in the economic and social framework of the Rio Grande do Sul state. The region of Serra Gaúcha in Rio Grande do Sul is known for its economic and social development, with metal mechanics, tourism, and the wine industry as its main sectors. The Automotive Metal-Mechanic Cluster (AMMC) is the second-largest in Brazil, with a turnover of US \$4.0 billion in 2020, comprising mostly micro and small companies (95%) and generating around 52,000 jobs (Simecs, 2021). The AMMC covers 17 municipalities in the region, with Caxias do Sul hosting the largest number of companies and representing about 60% of its Gross Value Added (GVA). Notably, while existing literature highlights numerous instances of innovation ecosystems led by academia or government, the Serra Gaúcha region distinguishes itself by predominantly featuring business-led endeavors that foster the establishment of a regional innovation ecosystem.

Finally, for the third paper, in order to assess the impact of openness on the performance of regional innovation ecosystems in Rio Grande do Sul, we conducted a survey involving firms, universities, and government entities. Data collection spanned from August 2022 to March 2023. The initial phase included a pre-test with 20 participants who responded via email. Starting in October 2022, data collection expanded to individuals working in the innovation sector, contacted through email and social media, with responses collected on the Survey Monkey platform. The survey garnered 200 valid responses.

The survey data collection is limited to the State of Rio Grande do Sul that offer a rich context for open innovation phenomena. Rio Grande do Sul is recognized as an innovative state (CNI, 2020) and has invested significantly in technological clusters, parks, and incubators to boost its innovation infrastructure. Rio Grande do Sul is the third most innovative state in Brazil (FIEC, 2022), being the most innovative state in the southern region of the country. In addition, the state has an innovation infrastructure as a significant competitive advantage, both nationally and internationally, being the fifth largest GDP in Brazil (IBGE, 2023).

The Inova RS is a program that aims to include the state of Rio Grande do Sul as a regional innovation ecosystem on the global innovation map through the construction of strategic partnerships between society, companies, academia, and government sectors in eight macro-regions of the state (Inova RS, 2023). The Inova RS program fosters partnerships between society, companies, academia, and government to drive economic and social development using the state's existing assets.

The context of emerging countries holds the potential to provide valuable insights into how open innovation is implemented and what barriers may hinder positive outcomes for the

regional innovation ecosystem. This dissertation was structured in three papers that will be presented next with their respective objectives and research methods.

1.4 Structure of dissertation

This dissertation is organized in three papers, besides the introduction and the conclusions. The first paper is entitled “A life cycle perspective on open innovation and ecosystems”. The second paper is “The role of open innovation in a regional innovation ecosystem: the case of Serra Gaúcha”. And in the third part there is the paper “The influence of openness in the performance of regional innovation ecosystems”. The three papers seek to answer the general and specific objectives of this dissertation and to fill the gaps identified in the literature. In the sequence, each paper will be presented.

The **first paper** of the dissertation, titled "A life cycle perspective on open innovation and ecosystems," is a theoretical essay and proposes an integration between the literatures on open innovation and innovation ecosystems, given the similarities between these approaches as they have evolved over the past two decades. Hence, the main argument of the article is that open innovation is a necessary condition for the development of innovation ecosystems. In this regard, as we seek to address gaps that still require theoretical depth regarding how ecosystems evolve and become sustainable, as well as how open innovation manifests at the interorganizational level (West & Bogers, 2014; Bogers et al., 2017; Gao et al., 2020), we have proposed dimensions of open innovation analysis using the heuristic tool of the life cycle to unveil at each stage of innovation ecosystems which practices, mechanisms, and levels of openness are manifested.

The **second paper**, titled "The role of open innovation in a regional innovation ecosystem: the case of Serra Gaúcha," adopts a qualitative case study approach and aims to evaluate the role of open innovation mechanisms within the regional innovation ecosystem of Serra Gaúcha. The selection of the regional innovation ecosystem of Serra Gaúcha as a case study was based the region's economic and social importance within the state of Rio Grande do Sul, where it is recognized as a vital industrial hub in Brazil, particularly in the automotive metal-mechanic industry. Moreover, unlike many other innovation ecosystems in the literature that are primarily driven by academia or government, the Serra Gaúcha region stands out for its emphasis on business-led initiatives in establishing the ecosystem.

The management literature suggests that ecosystems can be viewed as the outcome of diverse mechanisms and actors coevolving over time. However, Yaghmaie and Vanhaverbeke

(2020) point out that there is a lack of information about open innovation mechanisms at the ecosystem level, which could potentially pose challenges to the implementation of open innovation-based management. This challenge may be particularly relevant in the context of emerging countries, such as Brazil, as the impact of openness on innovation outcomes may vary due to different knowledge options available (Kafouros and Forsans, 2012) and team capability (Redding and Witt, 2007).

Lastly, the **third paper**, titled "The influence of openness on the performance of regional innovation ecosystems," presents a quantitative study conducted within the regional innovation ecosystem of Rio Grande do Sul. The study used a survey on firms, universities, and government entities within the state to collect the data and employed structural equation modeling (SEM) to analyze the gathered data. This study is performed in the context of the Inova RS, a program that aims to include the state of Rio Grande do Sul as a regional innovation ecosystem on the global innovation map through the construction of strategic partnerships between society, companies, academia, and government sectors in eight macro-regions of the state (Inova RS, 2023). The Inova RS proposes the construction of a common agenda among the actors of these regions' innovation ecosystems. This agenda articulates projects aimed at the economic and social development of the regions, employing the existing assets in the state. This study aims to contribute to the debate by incorporating the various actors involved, including the Triple Helix, such as universities, state and municipal governments, companies, and non-governmental organizations actors who contribute to creating an enabling environment for innovation.

The three papers formulated in this dissertation aim to address the objectives of this study and bridge the gaps identified in the existing literature. In addition to the theoretical essay, the research employs a qualitative-quantitative approach, in which the case study serves as an in-depth exploration to generate understanding of the phenomenon and formulate propositions to be statistically tested in the quantitative research. Table 1 provides a concise overview of each paper comprising this research.

Table 1: Summarized papers presentation

	Paper 1	Paper 2	Paper 3
Title	A life cycle perspective on open innovations and ecosystems	The role of open innovation in a regional innovation ecosystem: the case of Serra Gaúcha	The influence of openness in the performance of regional innovation ecosystems
Purpose	To analyze the role and the mechanisms of open	To analyze the role of open innovation mechanisms in	To investigate the influence of openness on

	innovation throughout the life cycle of innovation ecosystems	the regional innovation ecosystem of Serra Gaúcha	the performance of a regional innovation ecosystem
Context	Open innovation and innovation ecosystems theoretical approaches	Regional innovation ecosystem of Serra Gaúcha	The Inova RS Program and the regional innovation ecosystem of Rio Grande do Sul
Method	Theoretical essay	Case study	Structural equation modelling (SEM)
Keywords	Open innovation; innovation ecosystem; openness; life cycle.	open innovation; regional innovation ecosystem; lifecycle; case study; emergent economies.	open innovation; openness; regional innovation ecosystem; performance.

Analyzing the three papers that constitute this dissertation, we observe a logical sequence of study development. Initially, to comprehend the relationship between the open innovation and innovation ecosystems approaches, a thorough examination of the literature is necessary. Subsequently, through a case study, we empirically explore the mechanisms of open innovation at different stages of the life cycle of the regional innovation ecosystem of Serra Gaúcha. Lastly, we seek to understand the impact of the level of openness on the development of the regional ecosystem in Rio Grande do Sul. Thus, the composition of the three papers aims to answer the objectives defined in this dissertation (see Table 2).

Table 2: Relationship between specific objectives and papers

Specific objectives	Paper 1	Paper 2	Paper 3
To analyze the role of open innovation in different stages of the development of innovation ecosystems.	X	X	
To map the mechanisms of open innovation in different stages of the innovation ecosystem life cycle.	X	X	
To identify the influence of openness level in the performance of innovation ecosystems.		X	X

Finally, the results of this thesis do not intend to exhaust the discussion on open innovation in innovation ecosystems and the impact of implementing open innovation for social and regional development in developing countries. By exploring this theme, the research aims to shed light on the role of open innovation in the emergence and development of regional innovation ecosystems and the importance of stimulating actions that promote greater openness among the various actors involved in the ecosystem to collaborate. In the following chapters, we present the three complete papers that constitute the thesis, followed by the conclusion, which highlights the theoretical and practical contributions.

2. PAPER I:

A Life-Cycle Perspective on Open Innovation and Innovation Ecosystems¹²

¹ An early version of this paper was presented at the Simpósio de Gestão da Inovação Tecnológica (2021). Spindler, E.S.S., & Zen, C.A. (2021). The Dynamics of Open Innovation in the Life Cycle of the Innovation Ecosystems. XXXI Simpósio de Gestão da Inovação Tecnológica.

² A new version of this paper is currently under review at Journal of Open Innovation: Technology, Market, and Complexity. Spindler, E.S.S., Zen, C.A., Bogers, M.L.A.M., & Schutte, C. (2023). A Life Cycle Perspective on Open Innovation and Innovation Ecosystems.

Abstract

Given the dynamic nature to nurture an innovation ecosystem, this theoretical paper aims to analyze the role and the mechanisms of open innovation throughout the life cycle of innovation ecosystems. As open innovation is an integral part of developing innovation ecosystems, the life cycle perspective provides a dynamic view to analyze it. In this paper, we conducted a theoretical essay and explored the nexus of open innovation and ecosystems by developing a theoretical framework that provides a dynamic view of the role of open innovation in the life cycle of innovation ecosystems. Our theoretical contribution is twofold: firstly, we explain how open innovation enacts value creation and value capture through the life cycle of an innovation ecosystem. Secondly, we unravel the mechanisms in an innovation ecosystem, revealing that throughout each stage, outbound/coupled open innovation practices evolve along with the relationship between the actors involved enabling the value creation and value capture processes. Overall, we aim to open up new routes for future research to empirically validate the role of open innovation in the development of innovation ecosystems. Only a few studies have been concerned with the relationship between open innovation and innovation ecosystems. By using a life cycle perspective, we address the literature gap for interorganizational level studies and call attention to each stage of an ecosystem presenting outbound/coupled open innovation practices and their outcomes.

Keywords Open innovation; innovation ecosystem; life cycle.

1. Introduction

Innovation is increasingly being recognized as a distributed process that spans organizational boundaries. As such, open innovation has been developed as a perspective that emphasizes bringing together external and internal ideas in line with a business model that focuses on using such openness to create and capture more value from innovation (Bogers & West, 2012; Chesbrough & Bogers, 2014; Dahlander & Gann, 2010). There is an increasing interest in better understanding open innovation at different levels of analysis, ranging from individuals to ecosystems to regions (Bogers et al., 2017; Dahlander et al., 2021). This connects well the growing interest in innovation ecosystems as a perspective that highlights how a complex network of actors connects many different players to produce innovation cycles and jointly create value (Adner, 2017; Giannopoulos & Munro, 2019; Granstrand & Holgersson, 2020).

Going beyond the organizational level when exploring open innovation could not only generally deepen our understanding of the phenomenon, but it can also more specifically help to shed light on detailed processes and contingencies that will determine the success or failure of open innovation (West & Bogers, 2014; Vanhaverbeke et al., 2014; Bogers et al., 2018). The literature emphasizes the relevance of inter-organizational networks as a key factor in determining the ability to innovate successfully (Chesbrough, 2003; Bogers et al., 2017). Nonetheless, the current open innovation studies focus mainly on collaborations between organizations with only one partner, and therefore, stress new research possibilities, including multiple partners working together (Gao et al., 2020). Moreover, Holgersson et al. (2018) highlight the importance of a more dynamic perspective on open innovation, especially facing the evolutionary aspects of an innovation ecosystem.

In addition, we observe that the rise and development conditions of innovation ecosystems are still scarce in the literature and that there are several unanswered questions about the relation between open innovation and innovation ecosystems. Thus, even though the innovation management literature emphasizes that the open innovation approach can serve as a frame of reference that shapes actions in an innovation ecosystem (Wallner & Menrad, 2011; Vlaisavljevic et al., 2020) and underscores the importance of collaboration of actors within an innovation ecosystem, there is a lack of understanding about which configurations need to be present in the innovation ecosystem to create open innovation (Bogers et al., 2017). In addition, Yaghmaie and Vanhaverbeke (2020) point out that there is a lack of information about open

innovation mechanisms at the ecosystem level, which can result in potential challenges for practitioners to implement open innovation processes in an ecosystem.

In this context, we present the following research question: how does open innovation support the development of the innovation ecosystems? Given the dynamic nature of this development, this theoretical paper aims to analyze the role and the mechanisms of open innovation throughout the life cycle of innovation ecosystems. As open innovation is an integral part of developing innovation ecosystems, the life cycle perspective provides a dynamic view to analyze it. In this sense, we contribute to a deeper understanding of how open innovation helps to develop innovation ecosystems through different stages of life emphasizing that each stage presents different open innovation mechanisms that act to enable the value creation and capture in the ecosystem. Thus, the life cycle perspective provides a holistic point of view, which enables us to capture the dynamic and coevolutionary process (Moore, 1993) that is embedded in both the innovation ecosystem and open innovation literatures.

Our theoretical contribution is twofold: firstly, we explain how open innovation enacts value creation and value capture through the life cycle of an innovation ecosystem. Secondly, we unravel the mechanisms in an innovation ecosystem, revealing that throughout each stage, outbound/coupled open innovation practices evolve along with the relationship between the actors involved enabling the value creation and value capture processes.

This study is structured as follows. Section 2 presents a theoretical background on open innovation beyond the firm level. In Section 3, we stress the connections between open innovation and the innovation ecosystem to develop a life-cycle model of innovation ecosystem development. Section 4 further explains the open innovation practices and mechanisms through the life cycle stages. Finally, in Section 5, we present our contributions and implications, and suggest further research.

2. Open innovation: from firm level to ecosystem level

Open innovation is defined as “a distributed innovation process that involves purposively managed knowledge flows across the organizational boundary” (Chesbrough & Bogers, 2014, p. 4). These knowledge flows have been recognized and classified as inbound, outbound, and coupled (Gassmann & Enkel, 2004; Enkel et al., 2009). Later, Dahlander and Gann (2010) propose a classification matrix highlighting pecuniary and non-pecuniary open

innovation activities. Thus, the authors observe openness in organizations as a continuum from the different open innovation processes that they adopt in the innovation process.

Despite nearly two decades since Chesbrough (2003) coined the term, much effort has been done to unravel the inbound process (Chesbrough & Bogers, 2014), emphasizing mainly the firm level of analysis (Bogers et al., 2017). For example, West and Bogers (2014) propose a model of how firms leverage external innovations in which business models aim to capture value from the transfer of knowledge and create value for their business through open innovation practices.

However, when we address different levels of analysis, open innovation morphs into a more complex concept. It involves many players through multiple phases of the innovation process, as is the case of the acquisition, integration, and commercialization of innovation (Gao et al., 2020). Therefore, the operationalization of open innovation between collaborative networks and its capture of value and creation of value is extended to the community's level as in ecosystems (Chesbrough & Bogers, 2014).

Pustovrh et al. (2020) analyzed the practices of open innovation applied to develop entrepreneurial ecosystems. The open innovation approach makes it easier for coordinated and cooperative networks to emerge, have intra-network capture of value and external players, and create relationships based on horizontal and vertical links between the actors. In this way, for the development of complex innovation networks, as in the case of the innovation ecosystem, the creation of an environment ideal for the advent of innovation cycles (Giannopoulos & Munro, 2019) is also the creation of open innovation mechanisms to generate inflows and outflows of knowledge between the actors.

However, even though recent debates concerning open innovation stress the importance of different levels of analysis (Vanhaverbeke et al., 2014; Bogers et al., 2018; Dahlander et al., 2021), there are still very few studies that integrally cover the dynamic interaction between different levels (Bogers et al., 2017). Moreover, research addressing the interdependence of heterogeneous actors promoting open innovation are still scarce in the literature. Thus, we shed light on how open innovation enables value creation and capture at the ecosystem level.

3. Connecting open innovation to ecosystem

Chesbrough (2003) attributed a single term to a collection of practices already used by organizations, and thus, the open innovation approach has become an umbrella that directs,

integrates and connects a variety of existing activities that allow both academic and professional scope to rethink innovation strategies in a networked world (Huizingh, 2011). Thus, it is through open innovation that companies perceive the most permeable organizational boundaries, where there is a greater focus on shared knowledge flows and external interrelationships.

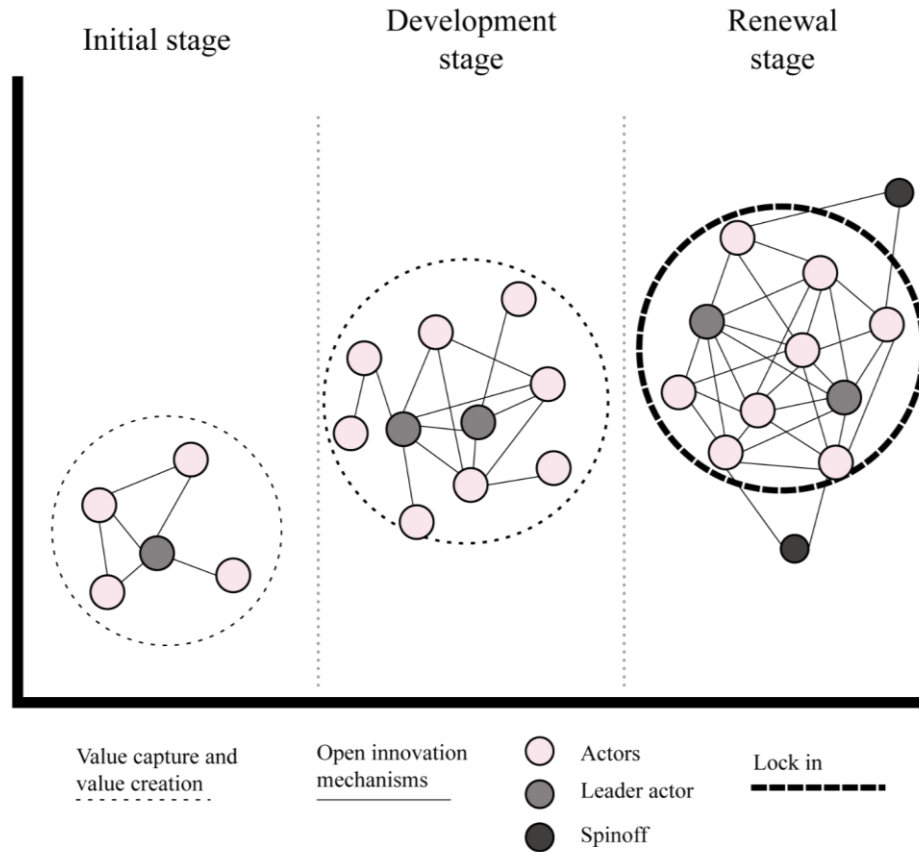
Therefore, one of the lines of study that has stood out is research on innovation ecosystems, since the understanding of how this phenomenon presents itself in complex networks of innovation, such as in ecosystems, is pointed out as one of the important frontiers of open innovation that it has the potential to unveil new avenues of approach (West & Bogers, 2017; Bogers et al., 2017; Mei et al., 2019; Gao et al., 2020). Likewise, the ecosystem approach also provides a relevant way for companies and other actors to take advantage of the interrelationships with external actors to create and capture value as part of an open innovation strategy (Bogers et al., 2019).

The open innovation approach can serve as a frame of reference that shapes actions in the context of an innovation ecosystem (Wallner & Menrad, 2011; Vlasisavljevic et al., 2020). However, although the literature has emphasized the importance of collaboration and the level of openness of actors within an innovation ecosystem, there is a lack of understanding about which configurations need to be present in the innovation ecosystem to create open innovation (Bogers et al., 2017).

Based on the literature review, we present elements of open innovation and innovation ecosystems that show that open innovation is a condition necessary for the development of innovation ecosystems. Among the common elements, we highlight as central to both approaches value creation (Radziwon et al., 2017) and value capture (Abdulkader et al., 2020), the presence and interdependence of diverse heterogeneous actors working together in innovative activities (Mei et al., 2019; Vlasisavljevic et al., 2020; Holgersson et al., 2018; Ferraris et al., 2020), alignment of strategic objectives (Radziwon et al., 2017; Vanhaverbeke et al., 2014), and competitive and collaborative relationships (Bacon et al., 2020).

So far, we have not found research that explicitly and fully explores the relationship between open innovation and innovation ecosystems that use the life cycle perspective to understand how open innovation presents at different stages of life in an innovation ecosystem. Thus, emphasizing the dynamic and co-evolutionary aspect of ecosystems, we propose, from Figure 1, an explanation of how open innovation can influence the emergence and development of innovation ecosystems.

Figure 1: A life-cycle model of innovation ecosystems and open innovation



Source: Elaborated by the authors.

In the initial stage of innovation ecosystems, only a few actors are participating. The lead actor has the role of orchestrating resources and initiating connections between participating actors to create common goals as a network (Dedehayir et al., 2018) enabling the value creation process within the network (Radziwon et al., 2017). Thus, open innovation mechanisms are initially established among the actors enabling the inflows and outflows of knowledge exchange. Alexy et al. (2013) suggest that selective knowledge disclosures are strategies identified in environments of high uncertainty, high coordination costs, and where actors are reluctant to collaborate. Therefore, the lead actor benefits from these knowledge disclosure mechanisms to solve problems and shape technologies at an early stage of ecosystem development, as well as improve their position within the network and in the market.

However, especially at this stage of ecosystems, it is important to highlight that open innovation mechanisms also create challenges for the transfer of knowledge due to the

organizational specificities of each actor, their experiences, and idiosyncratic practices. Thus, Miller et al. (2016) identify five factors that can facilitate or restrict knowledge transfer, which are human factors, knowledge characteristics, organizational factors, power relations, and network characteristics.

It is relevant to consider these factors to enable value capture by the initial actors that, at this point, are establishing themselves as a network. At this stage, the value creation of the network is still low and is more focused on instituting the network through the integration of activities between actors, which is a premise for achieving value co-creation in the innovation ecosystem (Oh et al., 2016). Thus, open innovation mechanisms provide better use of available resources to co-create value (Song et al., 2020).

As actors improve the level of openness of their business models, more value is shared across the ecosystem (Abdulkader et al., 2020). Therefore, in the development phase, a greater number of actors are participating, and open innovation activities are more numerous, not only in terms of the number of connections but also regarding the heterogeneity of the participating actors. At this stage, the lead actors focus on providing support to manage ecosystem assets.

Lin (2018) highlights the importance of the role of intermediaries in the development of innovation ecosystems. Besides facilitating the transfer of knowledge, they occupy a strategic position shaping open innovation mechanisms and promoting the interaction between different participating actors beyond dyadic collaboration flows. During the development stage, the capture and creation of value are established due to maturity in interactions among the participants and open innovation mechanisms.

At this stage, the ecosystem reaches a scale of development of innovative activities and outcomes of these collaborations not only within the network but for the surrounding environment. For this, Ahn et al. (2020) emphasize the importance of public policies in reflecting these mechanisms adopted to promote innovation not only for individual firms but for the entire ecosystem.

Finally, the innovation ecosystem renewal phase is when it reaches stability. In the life cycle proposed by Moore (1993) of business ecosystems, the author highlights that it is necessary to balance stabilization and changes within the ecosystem to incorporate new innovations and create a management team that can, if necessary, start a new ecosystem. Heaton et al. (2019), in turn, highlight the need for actors to have adaptive capacity at this stage to create new strategies for the ecosystem from external circumstances.

The renewal stage presents a higher level of connections and alignment between actors, but that does not necessarily result in more innovation, leading to a loss of competitiveness in the innovation ecosystem. In this sense, we contribute to this perspective by suggesting that stabilization and lock-in, at this stage, can be broken through open innovation mechanisms, in which spinoffs of ideas or new business models can emerge to renew the ecosystem as a whole, contributing to the creation of new cycles of innovation in the ecosystem (Giannopoulos & Munro, 2019).

In this way, open innovation enables the creation and capture of value throughout the life cycle of the innovation ecosystem. Thus, the value creation and capture processes develop and advance the stages of an ecosystem. However, although Figure 1 elucidates how open innovation works within the different stages of innovation ecosystems, it is lacking a discussion about open innovation mechanisms. Therefore, in the next section, we present open innovation mechanisms at the ecosystem level underlining practices and expected outcomes in each stage.

4. Open innovation in the life cycle of innovation ecosystems

Value creation is present in both open innovation and innovation ecosystems. For ecosystems, value creation is central for the end-user and other stakeholders in the development of an innovation ecosystem through its life cycle stages. For open innovation, value creation is seen through actors' relationships in the innovation process or the innovation as an outcome, also is permeated by value creation. Chesbrough and Bogers (2014) state that value capture and creation created at the firm level are extended to the ecosystem level through open innovation mechanisms.

Open innovation literature has shown how firms leverage the competition in ecosystems to exploit value creation and capture processes (Abdulkader et al., 2020). Thus, as an ecosystem is a valuable source for promoting inter-organizational activities, companies and other actors in the ecosystem have management strategies that reflect their business models and goals. Since actors are jointly interconnected and value creation and capture are shared processes within an innovation ecosystem, the success of the innovation ecosystem is dependent on the economic health of each actor and the assertiveness of the orchestration strategies employed in the ecosystem (Yaghmaie & Vanhaverbeke, 2020). Therefore, it is vital for the development and sustainability of the innovation ecosystem that the orchestration of this network ensures value creation and capture among actors (Nambisan & Sawhney, 2011).

However, in order to create and capture value, the ecosystem must deepen its relationships to create more complex collaborations and evolve. It emphasizes the interdependence, coevolution, and dynamic aspects of open innovation and innovation ecosystems because both approaches are dynamic processes coevolving based on interrelations between the actors. As Gao et al. (2020) point out, open innovation is seen as a dynamic process comprising human, technological and financial resources, which are present in the exchange flows between the players. Thus, open innovation orchestrates different players during the multiple phases of the innovation process, which means that there could be the involvement of different actors and resources in every stage of the innovation process.

The context also plays a critical role in developing an innovation ecosystem through open innovation mechanisms. The open innovation literature highlights that the internal context of the firm, like organizational culture and the size of organizations, influences the effectiveness of open innovation strategies. Also, external factors such as technological intensity, new business models, globalization, and the use of external knowledge can moderate the relationship between open innovation practices and innovative performance (Huizingh, 2011). Similarly, the innovation ecosystem literature stresses that the territory specificities influence how an innovation ecosystem evolves (Jackson, 2011). Hence, the regional context, including local infrastructure, specialized services available, and levels of trust between actors, impact the spread of innovations and local entrepreneurial activities (Alvedalen & Boschma, 2017). Therefore, public policies fostering open innovation culture in a region are paramount for the emergence and sustainability of an ecosystem (Ahn et al., 2020).

For Yaghmaie and Vanhaverbeke (2020), innovation ecosystems are a form of open innovation, as the interaction among multiple actors in the ecosystem allows some degree of coordination without the need for hierarchical and structured governance as in other networks. In this way, actors within the ecosystem can produce and market collaboratively developed products and services with fewer transaction costs. So, not only do results come from open innovation but how this innovation takes place is also part of open innovation practices, as open innovation shapes actions in the context of an innovation ecosystem (Vlaisavlejevic et al., 2020).

Then, as the innovation ecosystem encompasses important roles in the process of invention-to-commercialization (Järvi et al., 2018), different stages of the innovation ecosystem's life cycle present different practices and open innovation outcomes in order to create and capture value. In this sense, Table 3 stresses the open innovation mechanisms that

are necessary for the development of an innovation ecosystem throughout its stages. For this, we used the life cycle perspective proposed by Heaton et al. (2019) and the dimensions of open innovation as suggested by the specialized literature (Chesbrough & Bogers, 2014; Dahlander and Gann, 2010).

Table 3: Relation between the life cycle of the ecosystem and open innovation

	Initial Stage	Stage of Development	Stage of Renewal
Characteristics of the Stage	<ul style="list-style-type: none"> • Few actors • Rare interaction • Low identity 	<ul style="list-style-type: none"> • Organizations and support agencies with active participation • Communication channels are established by support agencies and organizations actively participating • Exchanges of knowledge 	<ul style="list-style-type: none"> • Stagnation of the established sectors. • New focuses for the innovation ecosystem.
OI Practices and Processes	<ul style="list-style-type: none"> • Lead actor – selective knowledge disclosure. • Companies and Startups – obtaining a flow of knowledge • Low demand for intellectual property 	<ul style="list-style-type: none"> • Outbound/coupled transfer among actors • Pecuniary and non-pecuniary open innovation • Intellectual property intensifies 	<ul style="list-style-type: none"> • Outflow of underused ideas • Encouragement of bringing up new partners to the ecosystem
Results of OI	<ul style="list-style-type: none"> • Establishment of links between companies • Creation of support players for the ecosystem • Enabling value creation and value capture • Ecosystem orchestration 	<ul style="list-style-type: none"> • Increase of innovations outcomes • Growth of intellectual property strategy • Establishment of trust • Generation of new business ventures 	<ul style="list-style-type: none"> • The peak of product development. • Specialization of the region. • Spin-offs of new business models for emerging markets

Source: Elaborated by the authors.

4.1 Initial stage

For the rise and sustainability of an ecosystem, companies and other players need to cooperate and compete in key activities (Heaton et al., 2019; Bacon et al., 2020), create relationships based on trust, and participate in different parts of the innovation process. This means that the leading player must take responsibility for nurturing partnerships and installing the platform necessary, acting as an intermediary (Lin, 2018) that orchestrates resources through selective knowledge disclosure mechanisms (Alexy et al., 2013) to establish interrelationships between actors and resources to create an innovation ecosystem (Dedehayir et al., 2018). As there are still only a few participating players and a high level of freedom between these, then the main actor must create processes for publicizing knowledge and making

available key technologies as necessary for the initial stage of an ecosystem (Ritala et al., 2013). At this stage, despite the challenges of connecting heterogeneous actors (Miller et al., 2016), one must align common goals and financial resources to enable value creation within the ecosystem (Radziwon et al., 2017).

Besides the lead actor, there are other important roles that must be organized for the emergence of the ecosystem. Heaton et al. (2019) highlight the university's role in creating conditions to ensure that the research reaches out to promising technological fields. Alam and Ansari (2020) state that fostering openness in public administration helps developing innovation ecosystems by integrating internal and external stakeholders. It promotes resource savings, reduces expenses, and creates a low-cost advantage. In this way, we can infer that the positive externalities of the region where the ecosystem is designed, have a strong influence on the advent of open innovation mechanisms that could speed up the emergence of an ecosystem.

As the lead actor is responsible for nurturing the relationship among actors, the flow of open innovation in the initial stage is mostly outbound involving non-pecuniary transactions (Dahlander & Gann, 2010). So, the lead player, to make sense to all actors involved and support the rise of an ecosystem, must establish goals and available resources among the participants. The authors described this process as non-pecuniary and involve disclosing internal resources to the external environment without any immediate financial reward. Moreover, in highly unknown environments, such as the initial stage of an ecosystem, the leading player uses selective disclosure of knowledge mechanisms to shape technologies and resources for other actors and to improve its own market position (Alexy et al., 2013).

Companies and startups might as well act as an ecosystem orchestrator, e.g., Berczki (2019). However, at this stage, when they are not leading up the orchestration of the ecosystem emergence, these actors are seeking connections within the network to share resources and advance in its innovative process (van Gils and Rutjes, 2017). As external sources of knowledge are paramount to promote innovation in an innovation ecosystem (Rocha et al., 2019; Nafizah and Tiara, 2018), the value capture process is enabled when establishing outbound practices within the network and there is a greater diversity of actors involved in different stages of innovation processes, leading up the ecosystem to the development stage.

4.2 Development stage

In the development stage of the ecosystem, local leaders must make an effort to support and expand the ecosystem's assets (Heaton et al., 2019). Thus, actors are more willing to share

knowledge inside the network, which generates a more intense inflow and outflow of knowledge. More complex open innovation practices and processes appear in this stage, e.g., acquiring knowledge, licensing, intellectual property outcomes, and technologies and innovations promotions for external stakeholders. Xie and Wang (2021) state that central actors in an ecosystem have access to more resources and better capabilities, allowing them to participate more in innovative activities. These open innovation activities lead the ecosystem to develop a critical mass (Heaton et al., 2019) and become more competitive.

Establishing actors' communication channels lead to higher trust level within the ecosystem and, consequently, outbound/couple processes as transfer technology intensifies. For example, at this stage, universities direct investors to companies and give guidance and support through offices for transferring technology to business people who wish to sell and license technologies and innovation on the market (Heaton et al., 2019). Also, public funding builds trust among the actors and paves the ground for more challenging innovation projects (Greco et al., 2021). It elucidates the maturity of open innovation mechanisms on setting pecuniary relationships in the knowledge transfer beyond the flow of knowledge established in the ecosystem's initial phase.

At this stage, partnerships among actors are tighter and innovation activities more intense, increasing the number of linkages and outflows in the network. As a firm's innovation activities are mainly influenced by the number of heterogeneous actors (Van de Ven & Walker, 1984; Mei et al., 2019), increasing the number of actors and practices entails multiple interrelationships among the actors. Thus, the deepened partnerships add more complexity to organize the knowledge flows, demanding new governance methods (Santos et al., 2021) in ecosystem management requiring coupled open innovation processes.

4.3 Renewal stage

The innovation ecosystem reaches its maturity when there is stagnation of established sectors, which Moore (1993) defines as self-renewal or death. For an innovation ecosystem not to cease to exist, Moore (1993) suggests that it is necessary to follow new trends to create innovation cycles and balance out stability and changes within the ecosystem. This stage presents high levels of trust, and actors understand their roles, communicating and articulating with other stakeholders without any intermediaries (Santos et al., 2021). Also, there is a high level of knowledge specialization, reaching the peak of new technologies development.

However, the network structure's formalization could bring obstacles and block novel innovations within the ecosystem. At the same time, knowledge specialization can generate greater homogeneity in the participants' capabilities that might lead to a lock-in process. At this moment, the literature stresses that the ecosystem could enter a period of decline for adapting its strategy to the new circumstances or undergo a period of renewal (Heaton et al., 2019).

The literature also stresses the coevolution of the market and technologies and players' adaptive capacity to create new strategies for the ecosystem based on external circumstances (Heaton et al., 2019). Thus, we argue that open innovation strategies, such as spin-offs and new business models to attend to the market trends can shape new innovation cycles (Giannopoulos & Munro, 2019) creating new strategies and aiming for new sectors to renew the ecosystem. In this sense, new partnerships with external stakeholders can bring up new capabilities and resources to the ecosystem creating new routes to explore as a network.

5. Conclusion

Open innovation literature stresses that innovation ecosystems are a crucial frontier to advance in the field (Bogers et al., 2017; West and Bogers, 2017). This theoretical paper reinforces open innovation as fundamental for developing innovation ecosystems by unraveling the role of open innovation in entailing the value creation and capture processes throughout an ecosystem life cycle. We addressed the research agendas on open innovation at different levels of analysis (Bogers et al., 2017; Bogers et al., 2019; Dahlander et al., 2021) and brought insights to unanswered questions from the literature on innovation ecosystems about how ecosystems develop over time (Jacobides et al., 2018).

This theoretical paper is a first attempt at explaining the role of open innovation in an innovation ecosystem. In this sense, the life cycle perspective allows one to have a broader view on open innovation emphasizing the coevolution and dynamic aspects of an ecosystem throughout the life cycle stages. By using the life cycle perspective, we were able to address the literature gap for interorganizational level studies and call attention to each stage of an ecosystem presenting outbound/coupled open innovation practices and their outcomes. In the initial stage, the lead actor uses mechanisms to create common goals among the actors and orchestrate resources. At the same time, other actors play different roles contributing to the ecosystem's emergence (Dedehayir et al., 2018). Further, when these partnerships are consolidated in the next stage, actors are more willing to share knowledge inside the network, which generates a more intense inflow and outflow of knowledge. More complex open

innovation practices and processes appear in this stage leading the ecosystem to become more competitive. In the renewal stage, open innovation can draw new routes to an ecosystem's renewal stage by renovating resources and bringing external stakeholders. Also, we highlight that historical positive externalities in a region might influence the emergence of an ecosystem that could speed up the emergence of open innovation mechanisms in the network.

Our framework opens an avenue for future studies that aim to investigate open innovation at the inter-organizational level. Thus, we contribute to open innovation literature by indicating that open innovation acts as an enabler to value creation and capture processes in innovation ecosystems. Also, by underlying mechanisms in each stage of an ecosystem, we shed light on how ecosystems emerge and evolve over time. These contributions help academics and practitioners to plan ecosystems' strategies considering open innovation mechanisms as a course of action to implement it. In this way, the open innovation approach facilitates the development of collaborative relationships between different players, thereby setting horizontal and vertical connections between actors in an innovation ecosystem. The scope of this paper aims to present a theoretical framework and explain the mechanisms of OI in each stage of the innovation ecosystem. Further studies should address ecosystems through open innovation mechanisms to validate these contributions empirically.

Regarding limitations of the study, we stress the importance of understanding how openness levels' participants influence the knowledge transfer and level of trust in the ecosystem in every stage of its life cycle. In this way, there is a remaining gap in the literature about openness at the inter-organizational level that must be addressed to further advance in the field.

As further studies, we call for both qualitative and quantitative research. For qualitative studies, case studies, focusing mainly on the renewal stage of an ecosystem, might address how open innovation creates new routes for a stable innovation ecosystem. Also, we highlight the importance of understanding the contingencies that emerging countries face to develop an innovation ecosystem through open innovation policies. For quantitative studies, new research might seek statistical evidence in the field and new ways to measure open innovation at the ecosystem level.

3. PAPER II:

The role of open innovation in a Regional Innovation Ecosystem: the case of Serra Gaúcha³⁴

³ This paper was presented at the Enanpad (2023). Spindler, E.S., Zen, A.C., & Bogers, L.M.A.M. (2023). The role of open innovation in a Regional Innovation Ecosystem: the case of Serra Gaúcha. XLVII Enanpad 2023.

⁴ This paper is currently under review at Management Decision, special issue “Open Innovation Adoption, Challenges and Firm Performance: Insights from Emerging Markets”. Spindler, E.S., Zen, A.C., & Bogers, L.M.A.M. (2023). The role of open innovation in a Regional Innovation Ecosystem: the case of Serra Gaúcha.

Abstract

Open innovation has been extensively studied at the firm level in developed economies. Further research is needed to explore other levels of analysis and the context of emerging economies as well. Therefore, this paper aims to discuss open innovation in regional innovation ecosystems in Brazil. We conduct a single case study to assess the role of open innovation mechanisms in the regional innovation ecosystem of Serra Gaúcha, Brazil. The study is based on in-depth interviews and secondary data in relation to the Quadruple Helix actors in the ecosystem. The results demonstrate that open innovation mechanisms are fundamental for the emergence and development of the regional innovation ecosystem, as it is through these mechanisms that actors can create identification as a network and organize the necessary knowledge flow for the ecosystem. Using a life cycle perspective, the study further demonstrates that different open innovation mechanisms are utilized throughout the development of the innovation ecosystem. We identify mechanisms in open innovation needed for organizations to engage with other actors in order to participate in and benefit from innovation ecosystems. Exploring open innovation in innovation ecosystems may provide valuable insights for both practitioners and academics.

Keywords: open innovation; regional innovation ecosystem; lifecycle; case study; emergent economies.

1. Introduction

Open innovation is a phenomenon that integrates external and internal ideas into a firm's business model to generate value and manage knowledge flows across organizational boundaries (Chesbrough & Bogers, 2014). While the concept of open innovation has been widely studied at the firm level, scholars have called for new avenues of research to explore the approach at other levels of analysis, such as inter-organizational, regional, or ecosystem levels (West & Bogers, 2014; Bogers et al., 2017). Additionally, there is a need to explore open innovation in emerging economies, as it has been underexplored in the literature. Developing economies face unique contingencies, such as institutional and social factors, and offer potential contributions to the open innovation literature by highlighting the challenges faced by open innovation in such contexts (Bogers et al., 2019).

According to Gao et al. (2020), existing research on open innovation focuses mainly on collaborations between organizations with only one partner, leaving a gap in the literature for investigating new possibilities with multiple partners working together. Furthermore, Bogers et al. (2019) and Hutton et al. (2021) emphasize the importance of identifying mechanisms in open innovation relationships to understand when organizations engage with other actors, participate in, and benefit from open innovation activities. In this sense, exploring open innovation in innovation ecosystems might help bring insights to practitioners and academia.

The management literature suggests that ecosystems can be viewed as the outcome of diverse mechanisms and actors coevolving over time. However, Yaghmaie and Vanhaverbeke (2020) point out that there is a lack of information about open innovation mechanisms at the ecosystem level, which could potentially pose challenges to the implementation of open innovation-based management. This challenge may be particularly relevant in the context of emerging countries, such as Brazil, as the impact of openness on innovation outcomes may vary due to different knowledge options available (Kafouros & Forsans, 2012) and team capability (Redding & Witt, 2007).

To address this gap in the literature, we aim to assess the role of open innovation mechanisms in the regional innovation ecosystem of Serra Gaúcha. To do this, a single case study was conducted in the south of Brazil because of its significance to the economic and social structure of the state of Rio Grande do Sul, the preponderance of business-driven initiatives in creating and establishing the regional innovation ecosystem, and as the region has been replicating open innovation methodologies for other ecosystems.

Our results demonstrate that open innovation mechanisms are fundamental for the emergence and development of regional innovation ecosystems, as it is through these mechanisms that actors can create identification as a network and orchestrate knowledge flow for the ecosystem. Using the life cycle perspective, we further demonstrate that different open innovation mechanisms are utilized throughout the development of the innovation ecosystem. Thus, we contribute to the literature by demonstrating the role of open innovation in different stages of ecosystem development and understanding that open innovation can impact the region's characteristics over time. Furthermore, by analyzing open innovation in emerging countries, we provide valuable insights into how institutional and cultural factors, such as high competition and low levels of trust, can influence collaboration development. These findings have significant implications for ecosystem literature, as they enhance our understanding of how ecosystems evolve and transform over time (Jacobides et al., 2018).

2. Literature review

2.1 Regional innovation ecosystem

The concept of innovation ecosystem originates from Moore's (1993) business ecosystems, but it was first introduced by Adner (2006) in the context of innovation platforms. Since then, the concept of innovation ecosystem has evolved dividing into non-spatial ecosystems focusing on a focal firm or platform (Adner, 2006) and spatial ecosystems emphasizing the collaboration of multiple actors and the influence of externalities within a delimited region (Radziwon et al., 2017; Cantner et al., 2021).

Regional innovation ecosystems rely on territorial approaches that consider regions and their external factors as essential elements for their emergence and sustainability (Dedehayir et al., 2018; Cantner et al., 2021). We understand regional innovation ecosystems as open and dynamic networks of interdependent actors (Jacobides et al., 2014; Suominen et al., 2019), including universities, industries, government, and civil society (Carayannis and Campbell, 2009), that co-evolve through waves of cooperation and conflict (Valkokari et al., 2017) creating and capturing value from collaboration (Radziwon et al., 2017) in a given territory.

The success of a regional innovation ecosystem relies on several factors, including ecosystem orchestration, actor collaboration, human capital quality, and infrastructure quality (Scaringella and Radziwon, 2018). Bittencourt et al. (2018) indicate that the lack of alignment among actors could have a negative influence on the development of innovation ecosystems. Alvedalen and

Boschma (2017) point out that the local infrastructure, specialized services, and trust levels among actors that constitute the ecosystem have a significant impact on the region's innovative activity. Santos et al. (2021) detail the mechanisms of orchestration in every stage of the ecosystem that might help to build a sustainable strategy throughout its life cycle.

The literature has identified key factors for ecosystems to succeed (Jacobides et al., 2014), but there is still a gap in understanding how ecosystems evolve sustainably over time (Yaghmaie & Vanhaverbeke, 2020). Some studies have used a life cycle approach (e.g., Moore, 1993; Heaton et al., 2019; Piqué et al., 2019) to understand the dynamics and coevolution of innovation ecosystems, identifying different stages of maturity based on stakeholder engagement, governance model, innovation outcomes, and trust.

In this research, we follow Heaton et al.'s (2019) life-cycle approach, which comprises three stages. The initial stage involves few actors, rare interactions, and a weak identity as an ecosystem. The lead actor plays a crucial role in initiating connections, orchestrating resources, and creating common goals (Dedehayir et al., 2018) to enable value creation within the network (Radziwon et al., 2017). In the development stage, supporting agents and organizations become active participants, and communication channels and exchange of flows are established. The renewal stage marks a shift towards new domains when established sectors stagnate and patent activity needs to be redirected.

The literature on regional innovation ecosystems has primarily focused on developed countries in Europe and the United States, with studies such as Visnjic et al. (2016) in Chicago, London, and Vienna, Oomens and Sadowski (2019) in Amsterdam, Piqué et al. (2019) in Barcelona, Helman (2020) in Poland, and Oskam et al. (2021) in the Netherlands. However, it is important to also consider emergent countries like Brazil, which face funding limitations and institutional complexity. Research in these contexts can provide insights into innovation ecosystem policies to drive competitiveness and innovation and contribute to the literature and practitioners by highlighting mechanisms for ecosystem emergence and development.

2.2 Open innovation in emerging economies

The concept of open innovation is defined as a distributed innovation process based on intentionally managed knowledge flows across organizational boundaries (Chesbrough & Bogers, 2014), which offers valuable insights into how firms can leverage knowledge inflows and outflows to enhance the success of their innovations. However, the phenomenon has been

addressed mostly at the level of the firm in the context of developed economies (Bogers et al., 2017; Bogers et al., 2019).

Firms operate within networks, industries, and sectors that are influenced by political and economic institutions such as regulation, intellectual property law, and capital markets (West et al., 2006). Therefore, open innovation is not solely dependent on a firm's willingness to collaborate, but also influenced by external factors such as the regulatory framework in which it operates (Bogers et al., 2019). External factors can either promote or hinder collaboration and knowledge sharing among various actors, including companies, consumers, universities, financial organizations, and civil society groups (Milagres & Burcharth, 2019). To access external knowledge and adopt open innovation practices, a favorable context that promotes collaborative processes is necessary (Felin & Zenger, 2014).

The literature on open innovation has primarily focused on industrialized economies, whereas emergent economies have received little attention, resulting in an incomplete understanding of the open innovation phenomenon in these contexts (Bogers et al., 2019). Only a few studies have investigated how open innovation is implemented in emergent economies, such as Brazil (Melo et al., 2020), India (Kafouros & Forsans, 2012; Naqshbandi et al., 2019), and China (Torres et al., 2020).

The primary challenge in emergent economies is to overcome disconnected innovation systems. Additionally, countries like Brazil face institutional and social contingencies that hinder the adoption of open innovation practices, such as a lack of trust, protectionist policies, high innovation costs, and perceived economic risks (Bogers et al., 2019). These institutional context act as a moderator factor that impacts the relationship between openness and innovation (Torres et al., 2020).

Firms also face internal barriers to implementing open innovation. Success in open innovation depends on factors such as organizational culture (Santoso et al., 2019), business model (Chesbrough, 2007), and industry type (Chesbrough & Crowther, 2006). In an open innovation model, organizational culture is crucial in promoting openness and acceptance in innovation with other stakeholders (Santoso et al., 2019). Pisano and Verganti (2008) emphasize the need to consider the firm's governance mode and adapt it accordingly to its strategy when adopting an open innovation model.

Successful open innovation implementation depends on how to collaborate with multiple stakeholders, using different communication channels, incentives, and property rights, making it a more complex process to manage when operating in the open innovation paradigm.

Thus, although the literature highlights that external connections might increase innovative outcomes (Felin & Zenger, 2014), it also brings more complexity to firms to manage (Bogers et al., 2019).

To assess external knowledge, firms can use various open innovation mechanisms (Chesbrough & Brunswicker, 2014). Then, by examining how open innovation mechanisms help the emergence of an ecosystem, we aim to contribute to the understanding of how ecosystems evolve (Jacobides et al., 2018) in the context of an emerging region.

2.3 Open innovation mechanisms

Only a few studies are addressing open innovation mechanisms at the network level (Ogink et al., 2023), which brings several challenges to how to implement open innovation activities successfully in ecosystems (Yaghmaie & Vanhaverbeke, 2020). In addition, most publications address empirical cases in developed contexts which underscores the insufficient understanding of open innovation implementation in emergent conditions. In this sense, emergent economies present a compelling opportunity to study the mechanisms employed to overcome contingencies such as the lack of trust and to establish co-creation practices among firms to develop a collaborative innovation ecosystem (Bogers et al., 2019).

The open innovation mechanisms for accessing external knowledge have different alternatives, such as contests and tournaments (Chesbrough & Brunswicker, 2014), alliances and joint ventures (Felin & Zenger, 2014), innovation intermediaries, such as corporate venture capital and incubators (Lin, 2018), licensing, open-source platforms (Chesbrough & Brunswicker, 2014), and participation in various development communities (Felin & Zenger, 2014). Additionally, networks such as regional innovation ecosystems are used as mechanisms to promote flows of obtaining, integrating, and commercializing innovation (Vanhaverbeke, 2006).

Ogink et al. (2023) conducted a literature review to identify and classify the various mechanisms observed in empirical open innovation studies. Table 4 summarizes their proposed fifteen open innovation mechanisms into four distinct categories. The first category, governance, and policies, pertains to the structures and procedures established to facilitate, steer and regulate open innovation activities. The second category, environmental dynamics, and interactions are concerned with the context in which open innovation activities occur, emphasizing how networks plan, operate, and perform. The third category, knowledge, skills, and capabilities, encompasses a range of capabilities that enable open innovation activities.

Finally, the fourth category, learning by doing, incorporates mechanisms such as tacit knowledge and collaborative prototyping that integrate learning while working within open project teams.

Table 4: Open innovation mechanisms at the network level

Categories	Key mechanisms
Governance and policies	Formal contracting, Organization permeability, value capturing, IP protection, Risk sharing, Integrated standardization
Environmental interactions and dynamics	Entrainment, Orchestration, Scouting, Innovation intermediation
Knowledge, skills, and capabilities	Absorptive capacity, Endowed knowledge base, Collaborative trust
Learning by doing	Tacit knowledge transfer, Collaborative prototyping

Source: Adapted from Ogink et al. (2023).

The literature highlights that firms use a combination of open innovation mechanisms in the project characteristics that they are participating in (Bagherzadeh et al., 2019). Thus, different innovation projects require different open innovation mechanisms (Felin & Zenger, 2019). Bagherzadeh et al. (2019) results show that most projects are developed by using a mixture of different open innovation mechanisms rather than just one mechanism. Thus, due to the characteristics of networks that are dynamic and evolve, such as in the regional innovation ecosystems case, we argue that the combination of open innovation mechanisms may be different following its lifecycle stage.

3. Research methods

This study employs a qualitative approach that draws upon primary and secondary data to examine the regional innovation ecosystem of Serra Gaúcha. The paper adopts a case study methodology as prescribed by Yin (2009) to analyze the ecosystem, which is composed of a diverse range of stakeholders, including firms, universities, government, and startups.

3.1 Case selection

The criteria used for selecting the case study of the regional innovation ecosystem of Serra Gaúcha were based on three factors. Firstly, the region's significance to the economic and social structure of the state of Rio Grande do Sul, where the regional innovation ecosystem of Serra Gaúcha is recognized as an essential industrial pole in Brazil. This is attributed to its high concentration of companies in the segments of parts, agricultural machinery, and vehicles,

which make it the second-largest automotive metal-mechanic industry in Brazil. Secondly, while the literature provides several instances of innovation ecosystems led by academia or government, the Serra Gaúcha region stands out due to its preponderance of business-driven initiatives in creating and establishing a regional innovation ecosystem. Lastly, the Serra Gaúcha region has served as a case study for open innovation methodologies that can be replicated in other regions.

3.2 Data collection

This research utilized both primary and secondary data. Data collection occurred between April 2022 and February 2023. Primary data were gathered through in-depth interviews with various stakeholders from the innovation ecosystem, including representatives from universities, corporations, non-governmental organizations, and state and local government officials. The dataset consisted of 19 interviews, with an average duration of 47 minutes per interview. Table 5 summarizes the details of all the interviews.

The secondary data collection was conducted using a collection of public databases, such as annual reports from the State Government regarding the innovation ecosystem, archives, reports, innovation laws, websites, and digital communication from open innovation programs and events. The secondary data served for triangulation across different data sources (Yin, 2009) and guaranteed reliability in the findings of the research.

Table 5: Summary of interviews

Interviews	Position	Actor	Organization	Duration interview (in minutes)
01	Director	Industry	Instituto Hélice	71
02	Director	University	TecnoUCS	52
03	Corporate Innovation Director	Industry	Semente Negócios	50
04	Head of Innovation	Industry	Conexo - Randon Company	71
05	Head of Innovation	Industry	Redesim	48
06	Innovation analyst	Industry	Marcopolo	40
07	Innovation analyst	Industry	Hyva	38
08	Head of Innovation	NGO Industry	Acelera Serra	40
09	Director	State government	Secretariat of Innovation, Science, and Technology	54
10	Innovation ecosystem Project Manager	State government	INOVA RS	60

11	Innovation ecosystem Project Manager	State government	INOVA RS	53
12	Secretary	Local government	Secretariat for Economic Development and Innovation of Caxias do Sul	56
13	Professor	University	IFRS	38
14	Professor	University	UERGS	49
15	Secretary	Local government	Secretariat for Development of Bento Gonçalves	56
16	Director	Industry	Union of Metallurgical of Caxias do Sul	38
17	Director	Industry	Meber	69
18	Director	Industry	Union of Metallurgical of Caxias do Sul	31
19	Director	Industry	Evolut	36

Source: Produced by the authors.

3.3 Data Analysis

Following the transcription of the interviews, a content analysis was conducted to examine the data collected as part of this research (Bardin, 2011). The main and intermediary categories were established a priori based on the literature review, representing the key topics of interest for the study. Table 6 outlines the categories selected for the research.

The categorization and data organization to further content analysis processes were conducted using the NVivo software, with the analytical scheme employed facilitating the triangulation of both primary and secondary data. The outcomes of this analysis were scrutinized and discussed within the context of existing literature on open innovation and regional innovation ecosystems.

Table 6: Deductive analysis categories

Main categories	Authors	Intermediary categories
Regional innovation ecosystem	Heaton et al. (2019); Alvedalen e Boschma (2017); Carayinnis et al. (2018).	Actors
		Infrastructure
		Governance
		Life cycle
Open innovation	Chesbrough e Bogers (2014); Dahlander e Gann (2010); Öberg e Alexander (2019).	Mechanisms
		Outcomes
		Openness

Source: Produced by the authors.

4. Results

The region of Serra Gaúcha in Rio Grande do Sul is known for its economic and social development, with metal mechanics, tourism, and the wine industry as its main sectors. The Automotive Metal-Mechanic Cluster (AMMC) is the second-largest in Brazil, with a turnover of US \$4.0 billion in 2020, comprising mostly micro and small companies (95%) and generating around 52,000 jobs (Simecs, 2021). The AMMC covers 17 municipalities in the region, with Caxias do Sul hosting the largest number of companies and representing about 60% of its Gross Value Added (GVA).

The Serra Gaúcha region features large nationally and internationally known companies, universities, and public structures. However, historically, these actors operated in isolation and competition, reflecting the region's culture. The Trino Polo, founded in 2002, was one of the first movements towards collaboration among actors in the city of Caxias do Sul, with a goal of boosting the IT sector. Nowadays, Trino Polo is a Local Productive Arrangement (LPA) comprising over 80 associated companies and 10 entities (Trino Polo, 2023).

4.1 Open innovation mechanisms in the Serra Gaúcha innovation ecosystem

Regional innovation ecosystems are dynamic interorganizational networks in which multiple interdependent actors participate (Suominen et al., 2019). These actors co-evolve through waves of cooperation and conflict (Valkokari et al., 2017), generating value for the network and the region in the innovation process within a delimited territory. In order to explore the evolutionary perspective of the ecosystem, we employ the heuristic tool of the life cycle based on the stages of Heaton et al. (2019).

4.1.1 Emergence and initial stage

The entrepreneurial movement in the region serves as a key driver for the development of an ecosystem. In Serra Gaúcha, the industries' role is an important milestone in the ecosystem's emergence. As the idiosyncratic characteristics of the region, including a culture of competition, individualistic profiles, and low levels of trust for collaboration, represent significant barriers that hinder organizations from collaborating.

The competitive mindset is very evident [in the region]. [...] I saw it happening. The competition was perhaps a survival mindset that allowed companies to thrive, even up until the end of the last century (Interviewee 1).

Earlier studies have confirmed the presence of a competitive mindset and low levels of collaboration and trust among actors in the Brazilian context (Pintec, 2014). In 2019, a group of entrepreneurs from large, traditional industries in the Serra Gaúcha region recognized the need for change and initiated the establishment of the Hélice Institute. This organization serves as a representative for companies seeking to become more open and collaborative through the implementation of open innovation processes, while also fostering a more widespread culture of open innovation throughout the region. The success of this collaborative effort is largely dependent on the development of a collaborative trust between industries and the identification of an orchestrator actor capable of effectively managing resources to support the emergence of a robust innovation ecosystem.

Another important milestone in the emergence of the regional innovation ecosystem in Serra Gaúcha is the creation of the Inova RS Program, which aims to include Rio Grande do Sul on the global innovation map by building strategic Quadruple Helix partnerships (Inova RS, 2023). The Program is promoted by the State Government and divides the state into eight regional innovation ecosystems and establishes the geographical boundaries of the Serra Gaúcha regional ecosystem. Inova RS was responsible for diagnosing the region and jointly developing with Quadruple Helix actors' strategic themes that the region has the potential to develop and create smart specializations in the areas of tourism, Industry 4.0, and smart cities.

The main legacy we will have from the Inova RS Program is the collaboration and interaction of actors. This collaboration will lead to new initiatives, projects, programs, and actions in the future. Previously, organizations that were not in contact with each other are now interacting through shared goals to develop the region (interviewee 13).

The emergence of an orchestrator is not always necessary for developing an innovation ecosystem. It depends on the ecosystem's structure. The role of an orchestrator is to coordinate knowledge flows and overcome challenges inherent in a collaborative network (Scaringella and Radziwon, 2018). In Serra Gaúcha, two organizations – Hélice Institute and Inova RS – occupied the role of orchestrating the knowledge flow to create a collaboration structure for the emergence of a regional innovation ecosystem. The main goal at this point was to align and share strategic objectives and establish various organizations of Quadruple Helix into an ecosystem. The leading actors were also responsible for promoting organizational permeability among other actors through institutional influence. Additionally, they were responsible for

aligning the cycles of activities of different actors in projects to provide the necessary structure for ecosystem emergence.

Summarized in Table 7, our results indicate that open innovation mechanisms are employed in the initial stage of regional innovation ecosystems to orchestrate resources and align various actors toward common goals. The emergence of lead actors who take on orchestrator roles in the ecosystem, such as the Hélice Institute and the Inova RS committee, are crucial in governing resources and aligning strategies. Their role contributes to increasing organizational openness among actors in participating in ecosystem activities and synchronizing activity cycles to achieve temporal fit. These findings contribute to understanding how the ecosystem emerges through actors orchestrating resources and also corroborate the innovation ecosystem literature that highlights different roles in the emergence of an ecosystem, such as forging partnerships and ecosystem governance (Dedehayir et al., 2018). Moreover, it reinforces the role of open innovation mechanisms in creating a regional innovation ecosystem (Yaghmaie & Vanhaverbeke, 2020). Thus, our first proposition is that:

PI. The establishment of open innovation mechanisms is fundamental for the emergence of regional innovation ecosystems.

4.1.2 Development Stage

According to Heaton et al. (2019), as an ecosystem becomes more consolidated and develops its network identity, there is a greater depth in the relationships among the actors. Interviews conducted in this study reveal that the collaboration between actors in the ecosystem has intensified, particularly through the coordination of leading actors, and that relationships have evolved beyond the scope of mapped projects. This finding indicates that participating actors in the ecosystem can capture value from their relationships and enhance their knowledge base through collaborative prototyping with other actors. As interviewee 11 emphasized, collaborative prototyping provides a means for increasing the knowledge base of participating actors in the ecosystem.

We began to see much more benefit in the relationships we were promoting within this ecosystem [...] if we could measure how many projects came out of Inova RS, from the actors of Inova RS because they met here, began to interact here [...] For instance, we saw a university, a company, and a municipality doing a project together because they

met at Inova RS, they started talking at Inova RS, and they were working on a project together (interviewee 11).

The literature highlights that when actors actively participate in innovation networks, they capture value by increasing their access to knowledge and resources and improving trust and external relations (Ogink et al., 2023). Our results are in line with the literature, as they show that the leading actors responsible for orchestration have a more decentralized role in the ecosystem as relationships deepen and the level of trust among other actors grows. We observed different projects among organizations being developed that were not initially involved in the ecosystem, such as partnerships between associations from different sectors and cities to develop events connecting with startups.

Through the entrainment of actors' cycles, an important outcome was observed in the development and execution of the Innovation Law of Caxias do Sul. The involvement of various actors, facilitated by innovation intermediaries such as Helice Institute, contributed to the construction of a law that effectively addressed the entrepreneurial needs of the region and strengthened the infrastructure of the innovation ecosystem. This finding is consistent with the literature, which emphasizes the institutional constraints faced by emerging countries such as Brazil, hindering the development of innovation ecosystems (Bogers et al., 2019). Hence, the collaborative development of laws that respond to the ecosystem's needs is crucial to consolidate and advancing the region as a network.

The best way to add up is to share, and in this case, sharing knowledge because, the innovation law was born much from sharing and a cool thing about this innovation movement is collaboration. So it brings a feeling that it creates a new culture (interviewee 12).

In the development stage, the results show that various mechanisms of open innovation are being employed to generate greater depth in the relationships among the actors. The absorptive capacity of the actors in absorbing the knowledge flow in the ecosystem increases its organization permeability, such as the example mentioned by interviewee 15.

The Union of Metallurgical of Caxias do Sul and the Union of Furnitures Sector of Bento Gonçalves, due to their involvement with Inova RS and also with the Helice Institute, ended up organizing a major event on technological innovation as a result of

this collaboration. Therefore, I would say that the great achievement of Inova RS today was to understanding that we need to be closer to each other (interviewee 15).

Our findings reveal that the regional innovation ecosystem life cycle stage in Serra Gaúcha employs various mechanisms to achieve the development of the innovation ecosystem. In the initial stage, governance, and policy mechanisms such as orchestration and organizational permeability predominate, enabling actors to establish common objectives and network identity. However, the development stage requires new mechanisms of open innovation for the execution of different projects. Previous research suggests that firms employ a combination of open innovation mechanisms based on project characteristics (Bagherzadeh et al., 2019). Thus, diverse innovation projects call for different open innovation mechanisms (Felin & Zenger, 2019). Therefore, we present our second preposition (P2a):

P2a. Different mechanisms of open innovation are necessary according to the stage of the regional innovation ecosystem.

Our findings indicate that the results generated by the same open innovation mechanisms differ based on the life cycle stage of the regional innovation ecosystem. Additionally, we found that orchestration evolves over the development of the ecosystem to facilitate the exchange of knowledge and resources among actors, without the need for hierarchical structures, and to decentralize coordination and decision-making within the ecosystem. As articulated by interviewee 4, collaboration among diverse actors was instrumental in bringing the theme of innovation to one of the most significant events in the Serra Gaúcha region.

Festa da Uva (Grape Festival) is a very traditional festival in the region, and we brought a great stage and an area called Innovation Soil, which was organized by around eighty entities. It was a massive business that lasted eighteen days with lectures, and the participation of Singularity, and Hyperloop (interviewee 4).

The literature underscores that as trust and collaboration between actors within an innovation ecosystem increase, the role of orchestration transitions from being primarily concentrated in a few leading actors to being occupied by different actors depending on the situation (Santos et al., 2021). Consequently, the same mechanisms employed in different

stages of an innovation ecosystem may produce varying outcomes, depending on the specific needs and objectives of the ecosystem at that particular stage. This leads us to our third proposition (P2b):

P2b. The same open innovation mechanisms can lead to different results depending on the stage of the innovation ecosystem.

Table 7: The role of open innovation mechanisms in the evolution of the regional innovation ecosystem of Serra Gaúcha

Ecosystem life cycle stage	Open innovation mechanisms	Leading actors*	Outcomes	Evidence
Initial Stage	Collaborative trust	I	The establishment of Helice Institute to orchestrate of intra-helix and extra-helix	The interaction between the four [companies]. 'Look, it worked [the collaborative movement], let's take a second step,' so it was decided to establish the institute: 'let's make a movement of open innovation' (interviewee 1).
	Organizational permeability	I, G, U, S	The actors' willingness to participate in the Serra Gaúcha ecosystem	Some things we won't be able to do alone, that's why we're investing in partnership with startups because we won't be able to develop them ourselves (interviewee 4).
	Entrainment	G	Synchronization of actors' cycle	Creation of the Strategic and Technical Committees of Inova RS for project alignment and ecosystem governance (Inova RS, 2023).
	Orchestration	I, G, U	Alignment of ecosystem strategy and common objectives	A regional diagnosis was performed collaboratively by the Inova RS committee and the Quadruple Helix actors to define strategic objectives at the ecosystem level (Inova RS, 2023). When we think about regional culture, it is a job that Hélice Institute has been doing very well, with the large companies in the region (interviewee 3).
Development stage	Orchestration	I, G	Enable resource and knowledge flows among actors	Grant programs funded by the State Government to provide financial support for projects aligned with the strategic objectives of the regional innovation ecosystem.
	Absorptive capacity	I, S	Actors' capability of creating their own open innovation strategies	The Secretariat for Economic Development and Innovation of Caxias do Sul organized an innovation event that involved universities and their students to develop solutions for the benefit of citizens.
	Innovation intermediation	I, G, U	Enabler of collaboration among different actors	Before, we only talked about connection with startups. Now, for certain challenges, we connect with universities or research institutes (interviewee 1).
	Entrainment	I, G, U	Desenvolvimento e execução de projetos para editais como o Inova RS	We are working as a network, not just launching a course and seeing if it has acceptance. It is about having conversations and seeing if it makes sense [for the ecosystem] (interviewee 4).
	Value capturing	I, U, S	Open Calls and challenges with startups and universities	Challenges that corporates prioritize to look for external potential partners, such as startups and universities.
	Tacit knowledge transfer	I, G, U	Collaborative project development and knowledge sharing.	We are organizing an innovation event here at the city hall service [...] in partnership with TECNOUCS, the technology park of UCS, which will bring the methodology and a group of students from a school to form teams together with the public servants (interviewee 12).
	Endowed knowledge base	I, G, U	Increasing knowledge of technologies and the digital economy	We had learned from the articulation with actors, but also in terms of methodology. For example, we identified that one of the main challenges was in [city] mobility. So we organized an innovation marathon (interviewee 11).
	Collaborative prototyping	I, G, U, S	Development of collaborative projects with different actors	Collaborative development of the Innovation Law of Caxias do Sul.

*(I) Industry, (G) Government, (U) University, (S) Society

Source: Elaborated by the author

Numerous studies have emphasized that developing economies face various contingencies, such as institutional and social factors, which may impede innovation practices (Bogers et al., 2019). The situation in Serra Gaúcha exemplifies the cultural and institutional obstacles that emerging economies may encounter. The region's culture is a significant factor, which interviewees mainly present as a hindrance to partnership development. According to interviewee 1, the transformation and collaboration of organizations commence with an intra-organizational initiative that eventually expands into an inter-organizational one.

How can we make this new way of working and mindset penetrate a culture that is used to competition? In 2018, the four founding companies [of Helice Institute] barely knew each other. Therefore, the initial movement was mainly driven by individuals who identified the need to change some behaviors within these companies (interviewee 1).

The cultural change in the region has been taking place thanks to the collaborative efforts of various actors within the ecosystem. However, the challenge remains to develop human capital for the knowledge economy. To address this, universities and the Helix Institute are collaborating to train individuals for innovation. This collaboration among ecosystem actors is laying the groundwork for long-term educational transformation and preparing people for work in knowledge-based organizations.

Each person has their own interests, obviously. There is nothing wrong with that. It's not wrong to fight for your business, your organization, or your segment. But when we try to build something, we should build it together. [...] It is really a change in mentality, a cultural change (interviewee 12).

The Serra Gaúcha region, known for its closed and competitive culture, has begun to actively collaborate with other regions through open innovation mechanisms. These findings support the literature that emphasizes successful open innovation initiatives can influence regional culture by strengthening knowledge capabilities, increasing the region's attractiveness to international companies, and strengthening connections with other ecosystems (Tödtling et al., 2011). Thus, our last proposition is:

P4. The establishment of a set of open innovation mechanisms is associated with cultural change in a region.

5. Conclusions and implications

Our study investigated open innovation mechanisms in the emergence and development stages of the regional innovation ecosystem in Serra Gaúcha. We contributed to the literature by identifying different innovation mechanisms at the ecosystem level and their outcomes, building upon previous studies (Bogers et al., 2017; Gao et al., 2020; Yaghmaie and Vanhaverbeke, 2020). Moreover, we explored how the institutional and social context of emerging economies, such as Brazil, influences the adoption of open innovation practices, providing valuable insights on addressing the literature gap identified by Bogers et al. (2019).

We believe our study has several contributions. First, our results indicated that open innovation is a key factor in the development of regional innovation ecosystems. We found that open innovation mechanisms are critical in the early stages of an innovation ecosystem, where they can facilitate the creation of a network identity and alignment of strategic objectives. Our findings support Dedehayir et al.'s (2018) conclusion that early-stage innovation ecosystems benefit from open innovation mechanisms created by leading actors to align objectives and orchestrate resources. Other studies, such as Bogers et al. (2019) and Hutton et al. (2021), stress the importance of identifying such mechanisms to understand actors' engagement and benefits in the ecosystem. Thus, by identifying different mechanisms throughout the ecosystem's life cycle, we show when actors participate in the ecosystem activities and how they use the resources to enhance their knowledge base and employ open innovation strategies. These insights help to devise strategies to overcome the challenges of emergence and development of innovation ecosystems, as highlighted by Yaghmaie and Vanhaverbeke (2020). We thereby contribute to a better understanding of the conditions that determine the evolution of innovation ecosystems (Holgerson et al., 2018; 2022).

Furthermore, our results specifically revealed that different open innovation mechanisms are utilized in different stages of the innovation ecosystem life cycle and that the outcomes of these mechanisms can vary depending on the stage in which they are applied. Our study corroborates the findings of Ogink et al. (2023) that open innovation mechanisms evolve with the innovation ecosystem and its collaboration dynamics. We also found that these mechanisms might have different outcomes depending on the stage of the ecosystem, with orchestration playing a more central role in the early stage and becoming a resource enabler as the ecosystem evolves. This finding aligns with Santos et al.'s (2021) view that governance decentralizes throughout the life cycle of the innovation ecosystem.

Finally, we identified that open innovation mechanisms have changed the characteristics of the region over time. The literature highlights that Brazil, as an emerging economy, faces challenges in building connected innovation systems as well as addressing social and institutional contingencies (Bogers et al., 2019). Our study focuses on the cultural change that the Serra Gaucha region is undergoing as actors within the regional innovation ecosystem collaborate more closely. We find that open innovation mechanisms play a critical role in fostering organizational openness and cultural transformation. Furthermore, our results suggest that through open innovation, actors are advocating for institutional changes that could improve access to innovation funds and infrastructure for the region. As much, we also add to the general understanding of the boundary conditions and contingencies that shape open innovation across various levels of analysis, including the regional and network levels (Bogers et al., 2017).

The managerial contribution of this research is threefold. First, regional leaders and policy-makers who aim to promote innovation within a region should prioritize open innovation mechanisms. Specifically, they should focus on establishing the necessary infrastructure to facilitate collaboration among actors in the Quadruple Helix. Second, the study also emphasizes the importance of considering the context of emerging economies, such as Brazil, when implementing open innovation practices. This insight can guide policy-makers and leaders in emerging economies to adapt and modify their strategies over time to better suit their institutional and social context. Finally, we highlight the importance of tailoring open innovation mechanisms to the different stages of an innovation ecosystem's life cycle. Understanding which mechanisms are most effective at each stage can help leaders and policy-makers to achieve more effective outcomes in promoting innovation and collaboration within their regional ecosystem.

While the study presented valuable contributions to the literature on open innovation and regional innovation ecosystems, we acknowledge the limitations of a single case study as it may limit the generalizability of the findings to other contexts. In addition, we understand that other factors may influence the adoption and the success of open innovation mechanisms at the level of the ecosystem. Thus, we encourage future research that can build on the findings of this study by examining the specific mechanisms and practices that are most effective at each stage of the regional innovation ecosystem life cycle. Additionally, as both open innovation and innovation ecosystems are mostly addressed for qualitative studies, quantitative research is welcome to contribute to the literature by exploring the influence of open innovation on the performance of regional innovation ecosystems.

4. PAPER III:

The Influence of Openness in the Performance of Regional Innovation Ecosystems¹

¹ An early version of this paper was presented at ISPIM 2023. Spindler, E.S., Zen, A.C., Schutte, C., & Arias-Pérez, J.E. (2023). The Role of Openness in the Performance of Innovation Ecosystems. XXXIV ISPIM Innovation Conference.

Abstract

Open innovation has received significant attention in the field of innovation management, with a growing emphasis on exploring new avenues beyond the firm level. Measuring the impact of open innovation, particularly within inter-organizational networks, presents a complex challenge. This study addresses the gap in understanding the impact of openness at the meso level, specifically within regional innovation ecosystems. These ecosystems involve diverse actors, including universities, government entities, and firms, working together to promote economic and social progress. While the literature emphasizes the benefits of openness, there is limited quantitative research exploring open innovation in ecosystems, particularly in the context of emerging economies. This paper aims to investigate the influence of openness on the performance of a regional innovation ecosystem by conducting a survey in the regional innovation ecosystem of Rio Grande do Sul, Brazil. The data collected were analyzed using structural equation modelling (SEM). Our results indicate that openness positively influences acquisition and exploitation capabilities, as well as ecosystem performance. The findings contribute to the literature on open innovation adoption in emerging economies and shed light on the contingencies that drive the sustainable evolution of ecosystems over time. The study emphasizes the importance of considering the level of openness within innovation ecosystems for companies seeking partners and adapting to changing needs. By examining the performance of a regional innovation ecosystem, this research adds to our understanding of the interplay between openness, capabilities, and ecosystem outcomes, providing valuable insights for practitioners and policymakers.

Keywords open innovation; openness; regional innovation ecosystem; performance.

1. Introduction

The concept of open innovation has gained significant attention in the field of innovation management over the past two decades. Open innovation is defined as “the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand markets for external use of innovation, respectively” (Chesbrough, 2006, p. 1). While open innovation has been extensively studied at the firm level, there is a growing call among researchers to explore other levels of analysis and uncover new avenues for this approach (Bogers et al., 2017; Dahlander et al., 2021).

Measuring open innovation, particularly its impact on inter-organizational networks, is a complex task. The literature has proposed various ways to measure open innovation, including external knowledge sources, internal knowledge, collaboration, technology exploitation and exploration, inbound and outbound open innovation, and the concept of openness itself (Carrasco-Carvajal et al., 2023). Openness is at the center of the open innovation approach, can be understood a continuum that assesses how open or closed a firm is, according with its level of openness (Dahlander & Gann, 2010).

However, the impact of openness on innovation outcomes may vary due to the availability of different knowledge options and the capabilities of teams (Kafouros & Forsans, 2012; Redding and Witt, 2007). Furthermore, little is known about how to measure the impact of openness at a meso level, such as the regional innovation ecosystem. There is a scarcity of quantitative studies in this field that explore open innovation and ecosystems, with most studies focusing on the firm level, particularly in platform ecosystems (Adner & Kapoor, 2010; Alam et al., 2022a).

In the context of regional innovation ecosystems, the various actors involved are more diverse, including the Quadruple Helix, such as universities, state and municipal governments, companies, society and non-governmental organizations (Carayannis & Campbell, 2009), all working together to support the creation and development of the ecosystem with the goal of generating economic and social progress in the region (Valkokari et al., 2017). This study aims to contribute to the debate by incorporating these important actors who contribute to creating an enabling environment for innovation.

Despite these insights, there is still a gap in understanding the contingencies that drive the sustainable evolution of an ecosystem over time (Holgerson et al., 2018; Yaghmaie and Vanhaverbeke, 2020). Companies participating in ecosystems must take into account the level

of openness within the innovation ecosystem to seek partners, review their openness strategy, and adapt quickly to changing needs (Alam et al., 2022a). In addition, the literature has stressed the importance of openness for the performance of firms (Laursen & Salter, 2006; Jungend et al., 2018).

In this sense, this paper aims to investigate the influence of openness on the performance of a regional innovation ecosystem. To answer this question, we conducted a survey in the regional innovation ecosystem of Rio Grande do Sul in the South of Brazil and the data were analyzed using structural equation modeling (SEM). The state of Rio Grande do Sul has implemented a program called Inova RS aimed at fostering regional innovation development. Inova RS draws inspiration from successful economic and social development initiatives, both within Brazil and internationally (Inova RS, 2023). Noteworthy references include initiatives such as Pacto Alegre in Porto Alegre, which strives to foster partnerships between the government and private sector, as well as national-level endeavors like Business Mobilization for Innovation. Additionally, projects like 22@Barcelona in Spain and Ruta N in Medellín have served as models, transforming urban dynamics through innovation and creativity.

Our study contributes to the literature by empirically examine the relationship between openness, acquisition and exploitation capabilities, and ecosystem performance in the context of Brazil, shedding light on open innovation adoption in an emerging economy. Moreover, we highlights the pivotal roles of various actors and their capabilities in fostering collaboration within ecosystems, emphasizing the dynamics of inter-organizational relationships. Lastly, we expand the focus beyond firms to encompass universities, government entities, and non-governmental organizations, providing a comprehensive understanding of regional innovation ecosystems and their potential for driving innovation and economic development.

2 Theoretical background

2.1 Openness, exploration and acquisition capabilities

Open innovation is a complex concept to measure its impact on an inter-organizational network. There are different ways to measure open innovation, such as through (i) external knowledge sources, internal knowledge, and collaboration; (ii) technology exploitation and exploration; (iii) inbound, outbound, and coupled open innovation; and (iv) openness (Carrasco-Carvajal et al., 2023).

Successful open innovation implementation depends on how to collaborate with multiple stakeholders, using different communication channels, incentives, and property rights, making it a more complex process to manage when operating in the open innovation paradigm (Gao et al., 2020).

The knowledge transfer process plays a significant role and presents itself as one of the most complex challenges that companies face when participating in interorganizational networks, such as innovation ecosystems (Milagres & Burchart, 2019; Radziwon et al., 2017). Therefore, organizations that employ open innovation strategies must be able to absorb external knowledge flows and exploit it in their business model. This organization's capability of internalizing external knowledge, recognize its value, assimilate it, and later apply it for commercial purposes is known as absorptive capacity (Cohen & Levinthal, 1989).

Open innovation has two capabilities that play a fundamental role, which are: acquisition and exploitation (Huizingh, 2011). The acquisition and exploitation of external knowledge are related processes, referred as inbound and outbound open innovation, respectively (Chesbrough, 2003).

The acquisition capability is related to the innovation activities to obtain knowledge from external sources and collaborate with various actors. On the other hand, the exploitation refers to the purposive use of intentional flow of knowledge to employ internal developments outside the firm (Cepeda & Arias-Perez, 2018).

Openness and exploitation and acquisition capabilities are highly related in the literature. Chesbrough (2003) argues that companies cannot rely solely on their internal R&D efforts to innovate. Therefore, a certain degree of openness to external actors is necessary to acquire and exploit external knowledge. Dahlander and Gann (2010) highlight acquisition as a type of openness that is related to obtaining external inputs for a firm's innovation process. Additionally, the authors also emphasize that openness is related to the process of making resources available for other actors to exploit. Furthermore, Alam et al. (2022c) suggest that a higher level of openness can facilitate the external exploitation of a firm's internal ideas.

Recently, Alam et al. (2022c) proposed a process that organizations face when they aim to enhance their level of openness and seek for faster innovation by accessing external resources and knowledge. The process begins with realization, where organizations identify the need for external resources. The socialization phase fosters familiarity and integration with other organizations and increases trust in taking risks by working with partners. In the strategic alignment phase, organizations align their objectives, activities, and resources. Finally, the two-

way openness phase involves inflows and outflows of knowledge and resources, further expanding organizational openness with partners.

As in a regional innovation ecosystem, in order to actors develop acquisition and exploitation capabilities to capture value from the network, they need to increase their openness with external actors. Based on these arguments, we propose our hypotheses:

H1a. Openness positively influences the actors' capability of exploitation in the regional innovation ecosystem.

H1b. Openness positively influences the actors' capability of acquisition in the regional innovation ecosystem.

2.2 Open innovation and regional innovation ecosystem performance

Innovation has expanded through the boundaries of the firms to be developed through collaboration with different players. Besides the different types of open innovation flows Chesbrough and Bogers (2014) described – inflow, outflow, and coupled -, the literature shows that interrelations between the organizations can occur in different ways: structured or non-structured, formal or informal, dyadic or with multiple players, and also be able to be ongoing partners or appear only in a certain period (Öberg & Alexander, 2019). Hence, there are different ways of setting up partnerships with other players, and there are also different degrees of openness to open innovation.

Openness is one of the critical points of the open innovation approach. The organization's openness concerns different players that the connection between external knowledge sources and the organization's internal knowledge base. Thus, the organizations' borders are permeable, as there is an inward and an outward flow of ideas, resources, and individual people. Thus, instead of a dichotomy, it is necessary to evaluate openness as a continuum, ranging from the fully close to the fully open, varying with the organizations' degree of openness (Dahlander & Gann, 2010; Gao et al., 2020).

The adoption of a more open strategy is potential source of competitive advantage for organizations, as it enables the acquisition of new knowledge, customer attraction, and differentiation from competitors (Henkel et al., 2014). However, the degree of openness within organizations is influenced by various internal and external factors that impact innovative performance. Regarding internal factors, Scaliza et al. (2022) highlight the importance of organizational culture in shaping the degree of openness, with aspects such as adaptability,

flexibility, and creativity being positively associated with innovation outcomes, whereas hierarchical cultures may inhibit open innovation. On the other hand, Torres et al. (2020) identified that institutional factors are critical moderators of the relationship between openness and innovation, with institutional complementarities being particularly important.

Similarly, the regional innovation ecosystem's performance relies on several factors, such as the orchestration of the ecosystem, the level of collaboration between actors, the quality of the human capital, and the quality of the infrastructure (Scaringella & Radziwon, 2018). Bittencourt et al. (2020) indicate that the lack of alignment among actors could have a negative influence on the development of innovation ecosystems. Alvedalen and Boschma (2017) point out that the local infrastructure, specialized services, and trust levels among actors that constitute the ecosystem have a significant impact on the region's innovative activity.

The literature has emphasized that open innovation can have an impact on innovative performance. Laursen and Salter (2006) state that a firm's willingness to collaborate with different players can enhance its ability to innovate. Tomlinson's research (2010) indicates that vertical cooperation has a positive effect on innovative performance. According to Jugend et al. (2018), both internal and external collaboration have a positive influence on the innovative performance of Brazilian firms.

Furthermore, openness can be utilized as a strategy for organizations to attain their strategic objectives, as organizations may choose to increase or decrease their level of openness based on their strategic goals. For instance, organizations may raise their degree of openness to innovate rapidly in order to gain an edge over their rivals, and then transition to a more closed approach once they have established market leadership (Dahlander et al., 2021).

However, most studies that examine the relationship between openness and performance concentrate on the firm level. To analyze performance at the ecosystem level, we rely on Alam et al.'s research (2022a), which validates five constructs for assessing inter-firm openness in innovation ecosystems. Therefore, considering these arguments, it is crucial to enhance our comprehension of the connection between openness and the performance of innovation ecosystems. Thus, we propose the following hypothesis:

H2. Higher openness positively influences the performance of the regional innovation ecosystem.

Besides the influence of openness, the literature of innovation management has emphasized the importance of collaboration and external knowledge for improving innovative performance. Laursen and Salter (2006) suggest in their study that external sources might increase innovation performance of a firm but must be tempered by the costs of such efforts. For Felin and Zenger (2014), external connections might increase innovative outcomes. Scaliza et al. (2022) state that the efforts that intensify collaboration with the actors in the innovation ecosystem tend to strengthen the relationship between open innovation and innovative performance. Ritala et al. (2015) suggest that external knowledge-sharing has a positive association with innovation performance.

However, the value creation for a firm during the process of knowledge acquisition depends on its absorptive capacity (Cohen & Levinthal, 1990; Laursen & Salter, 2006), which involves the ability to scan the external environment for new knowledge and technologies and integrate them into the innovation process (Arbussa & Coanders, 2006). Similarly, to exploit the acquired knowledge in the market, a company needs "desorptive capacity" to share it with other actors in the ecosystem (Ahn et al., 2016). Conversely, Naqshbandi (2016) asserts that the open innovation performance of an organization depends on its ability to explore and exploit knowledge.

Numerous studies have focused on measuring the performance of open innovation at the firm level. Hameed et al. (2018) and their subsequent study, Hameed and Naveed (2019), aim to measure open innovation performance using constructs composed of knowledge sharing, commercialization of ideas, communication with stakeholders, collaboration, and licensing IP. In contrast, Naqshbandi (2016) argues that an organization's open innovation performance depends on its ability to explore and exploit knowledge. However, despite studies linking open innovation and firm performance, there is still a need to understand the influence of open innovation on the performance of innovation ecosystems.

Additionally, the regional innovation ecosystem has a multi-level impact on innovation, as collaboration among actors can enhance their capabilities (Pellikka & Ali-Vehmas, 2018) and performance (Song, 2016), ultimately increasing the overall performance of the ecosystem (Talmar et al., 2018; Klimas & Czakon, 2022). The region's characteristics are particularly important in emerging countries such as Brazil, which are embedded in specific contexts with funding limitations and institutional complexities that also impact the ecosystem's performance.

Open innovation plays an essential role in allowing organizations to acquire and exploit the flow of knowledge to improve their performance (Radziwon & Bogers, 2019; Carrasco-

Caravajal, 2023). However, while most studies focus on the acquisition and exploitation capabilities from the firm's perspective, the context of interorganizational networks, such as in innovation ecosystems where multiple actors participate in the innovation process, remains largely unexplored. This context represents an important aspect for understanding the impact of these capabilities on the performance of the ecosystem. Thus, we present our hypotheses:

H3. Higher acquisition capabilities positively influence the performance of the regional innovation ecosystem.

H4. Higher exploitation capabilities positively influence the performance of the regional innovation ecosystem.

3. Method

The Inova RS is a program that aims to include the state of Rio Grande do Sul as a regional innovation ecosystem on the global innovation map through the construction of strategic partnerships between society, companies, academia, and government sectors in eight macro-regions of the state (Inova RS, 2023). The Inova RS proposes the construction of a common agenda among the actors of these regions' innovation ecosystems. This agenda articulates projects aimed at the economic and social development of the regions, employing the existing assets in the state.

To measure the influence of openness on the performance of regional innovation ecosystems, we conducted a survey in the regional innovation ecosystem in the Rio Grande do Sul with firms, universities, and the government. The data collection was conducted from August 2022 to March 2023. In the first stage, a pre-test was conducted with 20 participants who responded to the questionnaire via email. Starting from October 2022, data collection was initiated, encompassing people who work in the innovation area of companies, universities, and the government. Contact was made via email and social media, and the data were collected on the Survey Monkey platform. The questionnaires provided 200 valid responses. The characteristics of the sample is shown on Table 8.

The measurement instrument used in this study was a multi-item, seven-point Likert-type scale, following the methodology of previous research. The constructs and variables that compose openness were identified and tested by Alam et al. (2022), based on a mixed-method research with 54 in-depth interviews and 1,411 participants in a survey. The exploitation

capability and acquisition capability constructs were identified by Hung and Chou (2013) and tested by Cepeda and Arias (2019) in a survey with 233 participants.

The variables used to measure ecosystem performance were developed based on Klimas and Czakon's (2022) study, which proposes a classification of innovation ecosystem performance, divided into innovative performance, economic performance, and strategic performance. Although there is no consensus on how to measure performance, studies such as Jugend et al. (2018) and Ritala et al. (2015) indicate that improvements in open innovation have an impact on companies' innovative performance.

Table 8: Sample characteristics

Actors	Sample	Frequency (%)
Companies	123	61.5
Industry	34	17
Services	39	19.5
Startups	20	10
Cooperatives	14	7
Others	12	6
Research instituites	4	2
Universities	51	25.5
Private	20	10
Public	10	5
Scientific and Technological Parks	18	9
Others	3	1.5
Governement	26	13
Federal	3	1.5
State	16	8
Local	7	3.5
<i>Key informant's position</i>	200	100
Strategic	55	27.5
Tactic	85	42.5
Operational	57	28.5
Non identified	3	1.5

For data modeling, a Structural Equation Modeling (SEM) approach was employed. Four latent constructs were defined with its correspondent numbers of observable variables (Table 9): Acquisition (3 variables), Exploitation (4 variables), Openness (11 variables), and ecosystem performance (7 variables). The definition of these constructs was determined through an analysis of the contribution of each variable and the Cronbach's Alpha values. Variables with a weighted factor below 0.5 were excluded from the model. All tests were

conducted using the AMOS 26.0 software (Arbuckle, 2019) and the SPSS 20.0 software (IBM Corp, 2011).

4. Results

We collected 200 questionnaires, of which 61.5% were from companies, 25.5% from university respondents, and 13% from government respondents. Regarding the profile of the respondents, 27.5% hold a strategic position in the organization, 42.5% hold a tactical position, and 28.5% hold an operational position.

Since the variables in the research model are not directly observable, we used multiple manifest variables to assess them (Table 9). The construct of openness was measured using the model proposed by Alam et al. (2022a), which includes variables related to trust, knowledge and skills sharing, and information dissemination. The constructs of exploitation capability and acquisition capability, as proposed by Hung and Chou (2013), were measured using manifest variables of knowledge and asset commercialization and proactive search for external ideas and technologies. Lastly, the construct of ecosystem performance was measured using manifest variables related to the development of collaboration, opportunities, and innovation culture in the region.

Table 9: Constructs and variables of the measurement model

Constructs	Variables
Openness	<p>A1.2 – we trust in each other’s competence to achieve desired goals.</p> <p>A2.3 – we jointly devise new workable solutions to respond to problems or opportunities.</p> <p>A2.4 – we achieve desired goals more successfully through collaboration.</p> <p>A3.2 – we often share relevant knowledge with each other.</p> <p>A3.3 – we jointly organize training to complement each other’s skills.</p> <p>A3.4 – we share successful experiences with each other.</p> <p>A4.1 – we disclose relevant details that are useful for making informed decisions.</p> <p>A4.3 – we disseminate information in a timely manner to give each other sufficient reaction time.</p> <p>A4.4 – we are easily accessible to each other for any clarifications.</p> <p>A5.1 – we take a risk to rely on each other while making important business decisions.</p> <p>A5.4 – we take bold decisions for mutual benefits.</p>
Exploitation capability	<p>B1.2 – we have implemented formal practices to commercialize our technological knowledge and the intellectual property on the market.</p> <p>B1.3 – we have a department in charge of commercialization of knowledge assets.</p>

	<p>B1.4 – we welcome others to purchase and use our technological knowledge or intellectual property.</p> <p>B1.5 – we often exploit technological knowledge commercially along with outside organizations.</p>
Acquisition capability	<p>B2.2 – we regularly look for external ideas that allow the creation of value.</p> <p>B2.4 – we contact external organizations proactively to acquire technological knowledge and upgrade our products.</p> <p>B2.5 – we tend to build more alliances with external actors and rely on their innovation.</p>
Ecosystem performance	<p>D1.1 – in the last 3 years, our region has presented more opportunities for innovation support.</p> <p>D1.2 – in the last 3 years, our region has developed more connections between businesses, government, and universities.</p> <p>D1.3 – in the last 3 years, our region has brought more opportunities for transformation and improvement of businesses.</p> <p>D1.4 – in the last 3 years, our region has been seeking to develop an innovation-oriented culture.</p> <p>D2.1 – in the last 3 years, our region has become more competitive, generating greater financial gains.</p> <p>D2.2 – in the last 3 years, our region has generated greater economic returns from partnerships with other organizations in the regional innovation ecosystem.</p> <p>D3.3 – in the last 3 years, our region has developed more actions to promote regional technological development.</p>

To effectively evaluate the model-fit, it is important to consider multiple indices (Hair et al., 2006). The measurement and structural model (Table 10) shows that the model appears to have a statistically significant and adequate fit, as indicated by the Chi-Square test with a low p-value. The CMIN/DF ratio is below the recommended threshold of 3, indicating a good fit. Although the GFI and CFI values are slightly lower than the recommended thresholds, the RMSEA value indicates a reasonable model-data fit (Browne & Cudeck, 1993; Jöreskog & Sörbom, 1993; Hair et al., 2009). Additionally, the AIC value is relatively low, indicating that the model is relatively parsimonious and has a good balance between fit and complexity. Overall, the model appears to have a reasonable fit.

Table 10: Measurement and structural model

Categories	Variables	Measurement
Model Chi-Square	Chi-square	550.696
	DF – degrees of freedom	246
	P – value	<0.001
Model reliability	CMIN	550.696
	DF	246
	P	<0.001

	CMIN/DF	2.239
	GFI – good fit index	0.83
	CFI – comparative fit index	0.88
	RMSEA – root mean square error of approximation	0.079
	AIC - Akaike information criterion	708.69

The parameters estimated for each relationship and the acceptance or rejection of the hypotheses proposed in this study are presented in Table 11. Hypotheses were accepted if the standardized estimates were significant ($p < 0.01$) and positive.

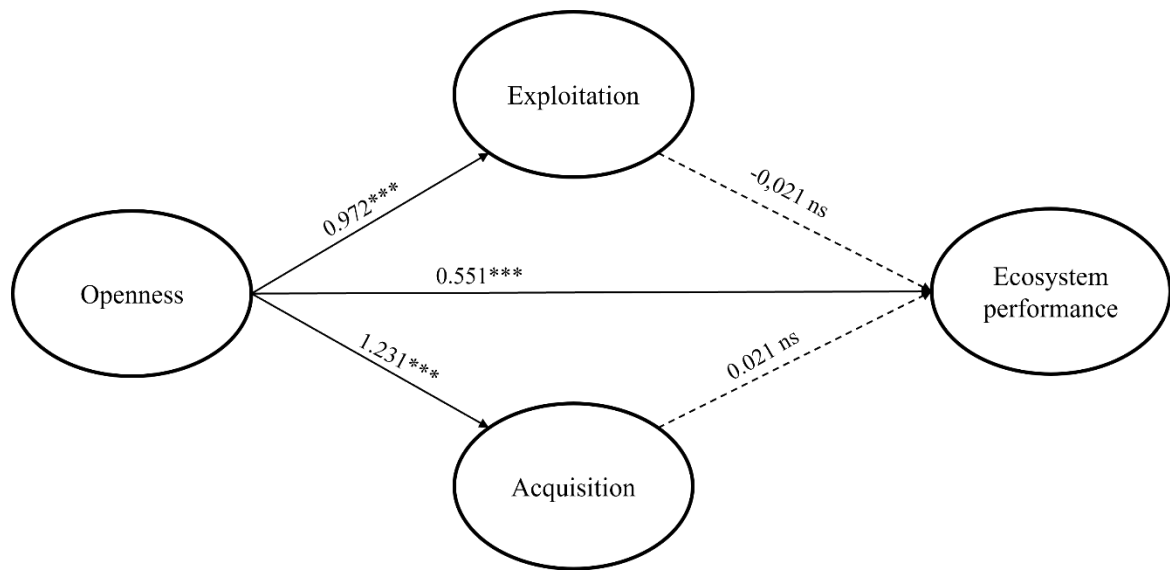
Table 11: Hypothesis testing

Hypotheses				Estimate	S.E.	C.R.	P
<i>H1a</i>	Openness	→	Exploitation	0.972	0.228	4.268	***
<i>H1b</i>	Openness	→	Acquisition	1.231	0.173	7.124	***
<i>H2</i>	Openness	→	Performance	0.551	0.095	5.792	***
<i>H3</i>	Acquisition	→	Performance	0.021	0.024	0.899	0.369
<i>H4</i>	Exploitation	→	Performance	-0.021	0.018	-1.191	0.234

The structural model is shown in Figure 2, including the significant positive and negative relationships and the rejected relationships. The results show that openness has a positive and significant influence on ecosystem performance (0.551). Hence, this study accepts H2. This result is consistent with the literature of open innovation that indicates that openness impacts the innovative performance of organizations in the ecosystem (Laursen & Salter, 2006; Scaliza et al., 2022).

In addition, openness also has a positive and significant influence on exploitation (0.972) and acquisition (1.231) capabilities. Therefore, H1a and H1b are accepted. We understand that organizations with higher degrees of openness enhance their acquisition and exploitation capabilities through sharing knowledge flows with other actors in the ecosystem. The hypotheses that acquisition (H3) and exploitation (H4) capabilities influence the ecosystem performance were rejected due to their non-significant results. The literature shows that acquisition and exploitation capabilities can influence the performance of the firm (Hung and Chou, 2013), but our results do not support this statement in the meso-level.

Figure 2: Final structured model



Legend:

- > Suggested relationship confirmed in the model
 - - - - -> Suggested relationship rejected in the model
 Notes: ns= non significant, *p<0.05; **p<0.01; ***p<0.001

5. Discussions and implications

This study has attempted to examine the influence of openness on the performance of regional innovation ecosystems. The SEM data analysis performed indicates a positive relationship between openness and the development of acquisition and exploitation capabilities among various actors within the regional innovation ecosystem. Additionally, the findings demonstrate that openness plays a significant role in shaping the performance of the ecosystem.

In emerging economies, such as in the Brazilian context, there is a weak regulation for intellectual property appropriation and protection (Keupp et al., 2012) which influences the adoption of open innovation practices and contribute to low trust levels (Alvedalen & Boschma, 2017). While most studies in the field focus on developed economies (e.g., Visnjic et al., 2016, Piqué et al., 2019) with high open innovation levels, such as in North America and Europe, Brazil provides an insightful context to study open innovation given its recognition for lower levels of open innovation adoption (Bogers et al., 2019). The findings underscore the correlation between the implementation of open innovation practices and enhanced collaboration in influencing positively the ecosystem performance even in contexts with institutional complexities and disconnected innovation systems.

Firstly, our results indicate a positive relationship between the level of openness among actors in the ecosystem and its performance outcomes. While the literature of open innovation argues that openness improves firms' innovativeness when properly managed, too much openness may hamper performance (Du et al., 2014). Fostering collaboration and exploiting the available knowledge flow within an ecosystem are key factors that contribute to increasing an organization's level of openness. This, in turn, leads to a greater number of innovation processes involving one or more organizations.

In regional innovation ecosystems in their initial stages, orchestrating actors play a crucial role in enhancing the collaboration among actors to increase the network's level of openness. By doing so, they aim to increase the resources available within the network to support innovation initiatives. In addition, the increase adoption of open innovation practices has transformed the corporate innovation strategies shifting investments from in-house R&D into the ecosystem (Holgerson et al., 2018). Thus, our results reinforce the typology of Klimas and Czakon's (2022) that promising innovation ecosystems demand actors with robust innovation capabilities and organizational innovativeness to successfully integrate the value chain. The actors' high-level competencies enable effective collaboration and ensure the seamless coordination of activities within the ecosystem.

Secondly, the findings indicate a positive relationship between openness and organizations' acquisition capability. This suggest that as organizations increase their level of openness, they are better equipped to leverage external knowledge, encompassing ideas and technologies that are accessible within the ecosystem. However, in order to effectively impact innovative performance, exploitation capability is necessary. In this sense, the results also suggest that acquisition capability alone does not influence on ecosystem performance. It implies that the access to knowledge and resources within the ecosystem is insufficient to generate a significant enhancement in the innovative performance of organizations in the ecosystem. Consequently, our study aligns with the insights of Ahn et al. (2016) in emphasizing the key role of absorptive capacity for organizations engaged in open innovation processes, since it enables organizations to effectively assimilate and utilize external knowledge to drive their innovation endeavors.

Thirdly, our findings indicate a positive relationship between openness and the organizational capability to exploit underused ideas and technologies. This result aligns with the findings of Alam et al. (2022b), which identify outbound openness as a more significant mediator than inbound openness in the pursuit of competitive advantage. The increased

collaborations and access to new resources provide actors with opportunities to leverage their assets in the market for potential partners. However, while our study did not establish a positive relationship between exploitation capability and ecosystem performance, Ahn et al.'s (2016) research suggests that outbound open innovation plays a crucial role in enhancing firm performance. We acknowledge that although firm performance is directly impacted by outbound open innovation practices, as knowledge commercialization to other organizations directly contributes to firm performance, the same does not necessarily extend to a regional innovation ecosystem. In a regional innovation ecosystem, the commercialization of technology does not have a direct impact on ecosystem performance.

Lastly, there are still few quantitative studies in the field exploring open innovation and ecosystems. Among these studies, most focus on the firm, exploring the phenomenon of open innovation in platform ecosystems (Adner & Kapoor, 2010; Alam et al., 2022a). In the context of regional innovation ecosystems, there is a greater plurality of participating actors, including universities, state and municipal governments, and non-governmental organizations that support the creation and development of the ecosystem with the aim of generating economic and social development in the region. Thus, our study contributes to the debate by adding important actors who support the creation of a conducive environment for innovation.

Similarly, the regional ecosystem of Rio Grande do Sul is shaped by government policies that promote collaboration among diverse actors in support of innovation. Our findings complement and reinforce the insights put forth by Scaliza et al. (2022), which underscore the pivotal role of the government as a driver of the innovation ecosystem. Specifically, the government plays a critical role in facilitating and coordinating the exchange and transfer of knowledge and technologies among actors within the ecosystem. Thus, our study demonstrates the influence of openness on the enhancement of acquisition and exploitation capabilities as well as its impact on the performance of regional innovation ecosystems. This underscores the importance for policymakers and ecosystem orchestrators to devise strategies that foster a higher level of openness among organizations, thereby promoting collaboration opportunities among actors.

6. Conclusions

We aimed to examine the influence of openness in the performance in regional innovation ecosystems in Brazil. Our results indicate that openness positively influences

acquisition and exploitation capabilities, as well as ecosystem performance. We address the gaps of exploring open innovation in the context of emerging economies (Bogers et al., 2019), employing empirical quantitative methods (Bogers et al., 2017) and contributing to the understanding for the evolution of regional innovation ecosystems (Holgersson et al., 2018; 2022).

Our contributions to the field are threefold. Firstly, we empirically examine the relationship between openness, acquisition and exploitation capabilities, and ecosystem performance within the context of Brazil, representing an emerging economy with institutional complexities related to open innovation adoption. Secondly, our study highlights the pivotal roles of actors and their capabilities in fostering collaboration within an ecosystem. Lastly, we shed light on the diverse range of actors involved in the emergence and development of regional innovation ecosystems, extending the focus beyond firms.

Our study provides valuable insights for policymakers and ecosystem orchestrators on how to enhance regional innovation ecosystem performance through the adoption of open innovation practices that promote effective collaboration and increased openness among ecosystem actors. Specifically, our findings demonstrate that openness is positively associated with both acquisition and exploitation capabilities, suggesting that ecosystem orchestrators can leverage these capabilities to enhance the perception of the ecosystem's value proposition for organizations operating within the region. These contributions offer a roadmap for policymakers and orchestrators seeking to foster a culture of open innovation and improve overall ecosystem performance.

While our results contribute to shed light to the existing literature by focusing on an important theme for the development of regional innovation ecosystems in emerging economies, we acknowledge the limitations of exploring the phenomenon at a regional level. The SEM method may be influenced by data availability and quality, and it can be challenging to gather reliable data from various actors within the regional level of an ecosystem. Therefore, further research should explore how different actors, particularly governments and universities, which have been underexplored in the literature, respond to higher levels of openness. Additionally, studies can investigate additional factors that impact the performance of these ecosystems. Moreover, it is necessary to investigate how the combination of different factors can optimize the emergence and development of regional innovation ecosystems.

5. CONCLUSION

The concept of open innovation is naturally linked to interorganizational relationships, however management research has predominantly focused on how individual firms manage resources within open contexts, rather than examining the impact of open innovation at the meso-level. This has led to a current debate in the field that spans different levels of analysis (Vanhaverbeke et al., 2014; Bogers et al., 2017; Bogers et al., 2018) as an opportunity to uncover the complexities of open innovation and gain a comprehensive understanding of the phenomenon. In this sense, the routes for contributing to the advancement of open innovation approach involve investigating open innovation in various contexts, including collaborations between organizations, sectors, and regions, to understand the factors that influence its success (Bogers et al., 2017).

Conversely, the present dissertation aimed to analyze how open innovation influences the emergence and development of regional innovation ecosystems in different stages of their life cycles. We have identified three main theoretical gaps that relates open innovation and regional innovation ecosystems. The first gap is related to how open innovation and innovation ecosystems approaches are interconnected using a life cycle perspective to comprehend the different stages of the ecosystem. The second gap refers to the mechanisms of open innovation employed in regional innovation ecosystems. Lastly, the third gap addressed in this dissertation explores open innovation in the context of emerging economies, which has been underexplored in the open innovation approach since its conception.

In the first paper, the objective was to analyze the role and the mechanisms of open innovation throughout the life cycle of innovation ecosystems. As a contribution, we approached the two themes in a theoretical essay and positioned open innovation as a driver for the development of innovation ecosystem in which open innovation acts as an enabler for value creation and capture processes during the evolution of innovation ecosystems. Based on the literature review, we presented a set of components to assess open innovation at different stages of the innovation ecosystem's life cycle. In the initial stage, the lead actor uses mechanisms to establish common goals among the actors and manage resources. Meanwhile, other actors perform different roles, contributing to the emergence of the ecosystem (Dedehayir et al., 2018). As partnerships are solidified in the next stage (development stage), actors become more willing to share knowledge within the network. This results in a more significant flow of knowledge, leading to the appearance of more complex open innovation practices and processes, ultimately

making the ecosystem more competitive. Finally, during the renewal stage, open innovation can pave the way for an ecosystem's revitalization by renovating resources and involving external stakeholders. Therefore, we contribute to a deeper understanding of how open innovation supports the development of innovation ecosystems through different stages of life emphasizing that each stage presents different open innovation mechanisms.

In the second paper, we aimed to assess the role of open innovation mechanisms in the regional innovation ecosystem of Serra Gaúcha. Firstly, the paper highlights the importance of open innovation in the development of regional innovation ecosystems. We found that open innovation mechanisms are crucial in the early stages of an innovation ecosystem, facilitating the creation of a network identity and alignment of strategic objectives. These mechanisms, established by leading actors, help align objectives and orchestrate resources, as supported by Dedehayir et al. (2018). Identifying such mechanisms throughout the ecosystem's life cycle sheds light on when actors participate and how they use resources to enhance their knowledge base and employ open innovation strategies, aiding in overcoming challenges in the emergence and development of innovation ecosystems, as noted by Yaghmaie and Vanhaverbeke (2020). This contributes to understanding the conditions that determine the evolution of innovation ecosystems (Holgersson et al., 2018; 2022).

Additionally, our findings reveal that different open innovation mechanisms are employed at various stages of the innovation ecosystem life cycle, with outcomes varying depending on the stage. This supports the idea that open innovation mechanisms evolve alongside the ecosystem and its collaboration dynamics, as observed by Ogink et al. (2023). Orchestration plays a more central role in the early stage and transitions to a resource enabler as the ecosystem evolves, aligning with Santos et al.'s (2021) perspective on governance decentralization throughout the life cycle.

Lastly, our study identified that open innovation mechanisms have influenced the characteristics of the region over time. The Serra Gaucha region, as an emerging economy, experiences cultural change as actors within the regional innovation ecosystem collaborate more closely. Open innovation mechanisms play a critical role in fostering organizational openness and cultural transformation, while also advocating for institutional changes that could enhance access to innovation funds and infrastructure for the region. This adds to the understanding of the boundary conditions and contingencies that shape open innovation at regional and network levels (Bogers et al., 2017).

In the third paper, our aim was to investigate the influence of openness on the performance of a regional innovation ecosystem. By conducting a survey within the Rio Grande do Sul regional innovation ecosystem, our results revealed that openness exerts a positive and significant impact on ecosystem performance. This suggests that promoting collaboration and utilizing knowledge exchange within the ecosystem contribute to enhancing firms' level of openness. Furthermore, our findings indicate a favorable correlation between openness and the abilities to acquire and exploit. As organizations increase their openness, they become better at harnessing knowledge from the ecosystem. However, the acquisition of knowledge alone does not solely influence ecosystem performance; the presence of exploitative capabilities is also essential for establishing a competitive advantage.

Thus, our contribution lies in empirically examining the relationship between openness, acquisition and exploitation capabilities, and ecosystem performance in the Brazilian context, which represents emerging economies characterized by institutional complexities in adopting the open innovation paradigm. Additionally, we explore diverse actors beyond firms within the regional innovation ecosystem, such as universities and government institutions, and their crucial roles in promoting collaboration within the ecosystem. Finally, our study offers valuable insights into enhancing the performance of the regional innovation ecosystem through the adoption of open innovation practices.

By presenting the paper's results and contributions, it is possible to identify that they effectively address the previously identified gaps while also contributing to a deeper understanding of the main objective of this dissertation, which is to analyze how open innovation influences the emergence, development, and performance of regional innovation ecosystems. To facilitate and consolidate these contributions, Table 12 is provided below.

Table 12: Paper's contribution and results

Paper	Objective	Contributions	Key results
A life cycle perspective on open innovations and innovation ecosystems	To analyze the role and the mechanisms of open innovation throughout the life cycle of innovation ecosystems	Theoretical framework to understand the adoption of open innovation in the life cycle of innovation ecosystems	The understanding of open innovation mechanisms in accordance with the life cycle stage of innovation ecosystems
		Open innovation as an enabler for value creation and capture processes during the evolution of innovation ecosystems	

The role of open innovation in a regional innovation ecosystem: the case of Serra Gaúcha	To analyze the role of open innovation mechanisms in the regional innovation ecosystem of Serra Gaúcha	Open innovation in the emergence of regional innovation ecosystems facilitates the creation of network identity and objective alignment	The empirical identification of open innovation mechanisms in the emergence, initial and development stages
		Different open innovation mechanisms are employed during the development of ecosystems	Four propositions: open innovation for emerging ecosystems; different open innovation mechanisms in each stage; same mechanisms can lead to different results; open innovation is associated with cultural change in a region
The influence of openness in the performance of regional innovation ecosystems	To investigate the influence of openness on the performance of a regional innovation ecosystem	Examine the relationship between openness, acquisition and exploitation capabilities, and ecosystem performance within the context of Brazil	Openness has a positive influence in the performance of regional innovation ecosystem
		Highlight various actors beyond the firm involved in the development of regional innovation ecosystems	We indicate a positive relationship between openness and acquisition capability
			We indicate a positive relationship between openness and exploitation capability

5.1 Theoretical contributions

Based on the aforementioned studies, we were able to analyze how open innovation operates during the different stages of the innovation ecosystem lifecycle, as well as emphasize the influence of the level of openness on the development and performance of these ecosystems. Thus, we propose that open innovation acts as a driver for the emergence, development, and performance of innovation ecosystems. Furthermore, we identified that throughout the lifecycle of these ecosystems, different mechanisms of open innovation are employed, creating opportunities for actors to collaborate and capture value from the network. Finally, the level of openness among actors was identified as a relevant factor for the performance of the innovation ecosystem, as different actors develop shared objectives and create increasingly complex collaboration processes as the ecosystem grows. Our studies provide numerous contributions,

both theoretical and managerial, to the fields of open innovation and regional innovation ecosystems.

We have contributed to the field of open innovation by emphasizing its relationship with innovation ecosystems, focusing mainly on regional innovation ecosystems, which are considered an important frontier for advancing the approach (Bogers et al., 2017; West & Bogers, 2017). In doing so, we address open innovation research agendas at the level of innovation ecosystems analysis (Dahlander et al., 2021) and provide insights to the innovation ecosystems literature by exploring their development over time (Jacobides et al., 2018). For instance, through qualitative case study research conducted in the Serra Gaúcha region, it was observed that greater engagement in the innovation process occurred as actors developed trust and collaborated over time, adding new mechanisms accordingly.

We have identified the role of open innovation as a driver of regional innovation ecosystems. Through both theoretical and empirical evidence, we have been able to pinpoint the various mechanisms at play within regional innovation ecosystems from their emergence to maturity, and how open innovation mechanisms work to create opportunities for innovative outcomes within the ecosystem context. It is through these mechanisms that actors are able to establish a network identity and align common goals in the early stages. Furthermore, we substantiate the findings of Dedehayir et al. (2018), which underscore the importance of leading actors in ecosystem emergence who orchestrate resources and establish networked goals. We also offer insights into how open innovation mechanisms employed at different stages of the regional innovation ecosystem's lifecycle can lead to distinct outcomes. Finally, we have demonstrated that the level of openness significantly impacts the performance of the innovation ecosystem. This influence is mediated through innovation mechanisms that orchestrate resources and facilitate the sharing of new knowledge among participating actors.

By employing a lifecycle perspective, we have emphasized the coevolution and dynamicity aspects of regional innovation ecosystems shedding light to the different open innovation mechanisms and practices during its evolution over time. Utilizing the lifecycle perspective facilitates a comprehensive examination of the ecosystem's evolutionary trajectory, encompassing subtle shifts in relationships and pivotal milestones of actors as they strive for collaboration within the ecosystem. Thus, we underscore the dynamics of change and their implications at the network level.

Besides that, we were able to demonstrate how the open innovation approach facilitates the development of collaborative relationships among various actors, thereby setting horizontal and vertical connections between actors in an innovation ecosystem.

We also contribute to a better understanding of the conditions that determine the evolution of innovation ecosystems (Holgersson et al., 2018; 2022), by identifying the actors' participation in the ecosystem activities and how they use the resources to enhance their knowledge base and employ open innovation strategies. These insights help to devise strategies to overcome the challenges of emergence and development of innovation ecosystems, as highlighted by Yaghmaie and Vanhaverbeke (2020).

Furthermore, the Brazilian context employed in this dissertation also constitutes a contribution to the field of open innovation, an area that has been relatively underexplored within emerging economies during the two decades of existence of this approach. Brazil is a country that the innovation literature often highlights for its low level of collaboration among diverse actors (Bogers et al., 2019), while concurrently, the institutional context of disconnected innovation systems negatively influences the continuity of innovative actions within the nation (Guerrero & Urbano, 2017). Through a case study of the Serra Gaúcha regional innovation ecosystem, we have uncovered that a combination of open innovation mechanisms facilitated by various actions from diverse actors over time has the potential to induce cultural changes within a region and enhance the openness of participating ecosystem actors. In this sense, our study shed light on the cultural change that the Serra Gaucha region is undergoing as actors within the regional innovation ecosystem become more collaboratively. We find that open innovation mechanisms play a critical role in fostering organizational openness and cultural transformation.

Lastly, the limited studies that quantitatively address open innovation and innovation ecosystems predominantly focus on the firm level (e.g., Alam et al., 2022a). In our research on the influence of open innovation on the performance of the regional innovation ecosystem in Rio Grande do Sul, we have identified a positive relationship between the level of openness among actors and the ecosystem's performance, which reinforces the role of collaboration for fostering innovation in a certain territory. In addition to this, we acknowledge that although firm performance is directly impacted by outbound open innovation practices, as knowledge commercialization to other organizations directly contributes to firm performance, the same does not necessarily extend to a regional innovation ecosystem. This contributes to the understanding of the effects of open innovation at the ecosystem level.

5.2 Managerial implications

The findings of this dissertation extend beyond theoretical contributions and also offer managerial insights for practitioners, policy-makers, orchestrators, and participants of regional innovation ecosystems, especially in the context of emerging economies as in Brazil.

The contribution of this research that indicates that open innovation acts as an enabler to value creation and capture processes in innovation ecosystems can serve as a strategic guidance for businesses and organizations within the ecosystem to adopt a more open and collaborative approaches to innovate. Also, these insights can contribute to educational purposes as it can be incorporated into entrepreneurial programs for students from elementary to graduate schools. It can help shaping the future of collaboration in the region and fostering the creation of new ventures, that can lead to greater outcomes and prosperity for the region as whole.

The innovation ecosystem environment plays a pivotal role in determining the availability of resources, actors, and the level of collaboration within a specific region. As such, orchestrators and leading actors aiming to foster the emergence of a regional innovation ecosystem must consider its unique characteristics and strengths to formulate a long-term strategy for the region. Our insights regarding open innovation mechanisms during the emergence phase of innovation ecosystems can assist regional leaders and policy-makers striving to promote innovation within a region. They can utilize open innovation mechanisms to identify collaboration gaps among different actors and to devise open innovation strategies that establish a network and enhance collaboration within the network and across sectors, such as fostering partnerships among industries, universities, and governments. This is especially relevant in the context of emerging countries, as explored in this dissertation, where isolated innovation efforts often face challenges due to institutional complexities.

We emphasize that it is not enough to merely establish initial and isolated connections within the ecosystem. Our work underscores the significance of comprehending the evolution of the regional innovation ecosystem and its interrelationships to design open innovation mechanisms that catalyze actor connections, fostering collaboration for innovation and generating value both for the actors themselves and the region considering the specificities and challenges of each stage of the ecosystem evolution. In this sense, ecosystems actors, such academics, government leaders and entrepreneurs can learn from these insights in several ways, such as by adopting long-term strategies, participating in events, platforms and programs that

promote interaction and knowledge sharing and promoting a more open organizational culture in the organizations to help them achieve better outcomes from the interactions with the ecosystem.

Furthermore, the dissertation elucidates the role of open innovation in instigating cultural shifts within organizations. This underscores the advantages of fostering greater level of openness towards collaboration with other organizations and the sharing of knowledge with partners to devise solutions tailored to the organization's needs, consequently enriching the value proposition of the regional innovation ecosystem. Although culture represents a multifaceted and intricate aspect, the proliferation of innovation initiatives and the consolidation of innovation ecosystem strategy can yield enduring benefits for the region, such as expanded business prospects and talent retention. Consequently, this might help mitigate the adverse effects of skilled individuals relocating from rural regions to urban centers in pursuit of employment opportunities.

Finally, our findings indicate that openness is positively associated with both acquisition and exploitation capabilities, suggesting that ecosystem orchestrators can leverage these capabilities to enhance the perception of the ecosystem's value proposition for organizations operating within the region. Thus, investing in programs to enhance the innovation capabilities of the participants in open innovation methods, technology adoption and innovation management can help the actors to make smarter use from the knowledge they are accessing in the ecosystem.

5.3 Limitations and further research

While developing this dissertation, various limitations were encountered, stemming from researcher choices, methodological generalizability constraints, and/or data accessibility. In this study, we have provided a comprehensive examination of two intricate domains: open innovation and regional innovation ecosystems.

By employing a case study approach, we acknowledge that the application of this method may limit the extent to which results can be extrapolated to other contexts. Additionally, since this dissertation is confined to employing the theoretical lens of open innovation for the analysis in the interorganizational network as the regional innovation ecosystem, we recognize that other contextual factors may influence the adoption and success of open innovation mechanisms at the ecosystem level.

Another important point to highlight is the data collection process in the quantitative study conducted in the context of Rio Grande do Sul. Due to the extensive and intricate nature of the data, it's important to acknowledge that, while statistically tested, the data is more concentrated in certain regions of the state. This could introduce bias to our research findings. This limitation arises mainly from the difficulty in accessing various actors within the Quadruple Helix across the entire state.

As a result, our study doesn't aim to cover every aspect of open innovation's impact on regional innovation ecosystems throughout their lifecycle. Rather, our goal is to provide insights and contributions to a developing field of knowledge. In this context, we outline potential avenues for future research that could enhance our understanding of open innovation within an ecosystem.

- a) Research that examines different combinations of employed open innovation mechanisms and identifies the most effective mechanisms in enhancing the performance of innovation ecosystems.
- b) Comparative studies involving regional innovation ecosystems in developed countries and emerging economies.
- c) Comparative studies between regional innovation ecosystems and platform-based innovation ecosystems, elucidating the application of open innovation in each context.

By pursuing these research avenues, forthcoming studies can expand upon the insights garnered from this dissertation, thereby advancing our comprehension of the complex interrelationship between open innovation and regional innovation ecosystems. These investigations hold the potential to enrich both theoretical frameworks and practical approaches for nurturing innovation and collaboration across a spectrum of regional settings.

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Appendix A - Semi-Structured Scripts for interviews (paper 2)

a) Roteiro para empresas líderes do ecossistema de inovação

Trajectoria da empresa	<p>Me conte um pouco de como a empresa foi fundada e como chegou até aqui. Quais as motivações que levaram a liderar o ecossistema de inovação aqui na Serra Gaúcha?</p> <p>Na tua visão, quais são os benefícios que traz para a tua empresa?</p> <p>E quais são os desafios de lidar com diferentes atores do ecossistema?</p>
Externalidades da região	<p>Como a região incentiva a criação de uma rede como o ecossistema de inovação? Para você, quais são os principais pontos positivos que a Serra Gaúcha oferece para uma empresa do porte da sua?</p> <p>Quais são os desafios que a região impõe?</p> <p>Você acredita que a história da região e as potencialidades dos setores estabelecidos influenciam no processo de criação do ecossistema? De que forma eles influenciam?</p>
Organização e inovação	<p>Como é a estrutura dos times e departamentos da empresa?</p> <p>Você tem uma equipe voltada para pensar inovação na empresa? Como acontecem esses processos?</p> <p>Possui área de P&D?</p> <p>Costuma buscar atores externos para promover inovação? Se sim, me cite exemplos desses casos, por favor.</p>
Práticas de Inovação aberta	<p>Quais são as principais parcerias estratégicas da tua empresa?</p> <p>Quais resultados você percebe?</p> <p>Existe resultados que você acredita que as parcerias com outras empresas te trouxeram, mas que não é possível mensurá-los? Se sim, cite alguns.</p> <p>Você costuma participar de reuniões setoriais e associações? Se sim, cite alguns exemplos e periodicidade.</p> <p>Há algum método de coleta de ideias internas para melhoria do negócio?</p> <p>Existe uma forma de coleta de ideias/ações externas?</p>
IA pecuniária (inbound e outbound)	<p>Você costuma comprar ou vender algum tipo de expertise para parceiros externos? Como conhecimento, licenciamento de produto ou marca que se ganha em royalties?</p> <p>Você enxerga essas práticas como importantes?</p> <p>Se não faz, gostaria de fazer?</p> <p>Quais as dificuldades de implementar práticas de venda de know-how na sua região?</p>
IA não pecuniária (inbound e outbound)	<p>Quais as principais fontes de informação que você percebe que influenciam o seu negócio?</p> <p>Você contribui enquanto empresa para essas trocas de informação entre empresas? Como?</p> <p>De que maneira as informações impactam o seu negócio?</p> <p>Você acredita que parceiros externos podem te fornecer informações valiosas sobre o mercado que impactem positivamente no seu negócio? Cite exemplos.</p>

Resultados da inovação aberta	Como as parcerias com outras empresas agregam valor ao seu negócio? Você acredita já ter se beneficiado de conhecimento de outras empresas? Me conte a sua experiência. Você acredita que outras empresas percebem o seu negócio como fonte de informação para o mercado?
Nível de abertura (amplitude e profundidade)	Você participa de alguma rede de negócios com outras empresas? Que tipo de empresas também participam? Há concorrentes? Como é a relação de vocês em redes que também participam concorrentes diretos? Qual o tipo de informação que vocês compartilham? Vocês desenvolvem projetos juntos? Cite exemplos. Quais os desafios que é participar de uma rede com outras empresas? Quais os benefícios que você enxerga como participante?
Criação e captura de valor	Na sua visão, o que o ecossistema contribui para a região? E o que o ecossistema contribui para os atores participantes? De que maneira você percebe valor nas contribuições do ecossistema para a sua empresa? Como você se apropria da participação no ecossistema?

b) Roteiro de entrevista para gestores do ecossistema de inovação

Trajatória do ecossistema	Me conte um pouco de como o ecossistema foi desenvolvido e como chegou até aqui. De qual organização você é? Como você foi parar na gestão do ecossistema? Foi intencional? Quais são os benefícios e desafios de gestão do ecossistema? Quem mais faz parte da gestão? Os atores não participantes podem contribuir também? Como isso acontece?
Externalidades da região	Como a região influencia a criação de uma rede como o ecossistema de inovação? Para você, quais são os principais pontos positivos que a Serra Gaúcha oferece para o ecossistema? Quais são os desafios que a região impõe? Você acredita que a história da região e as potencialidades dos setores estabelecidos influenciam no processo de criação do ecossistema? De que forma eles influenciam? Há políticas de incentivo para o ecossistema?
Organização e inovação	Como é a estrutura do ecossistema atualmente? De que forma se desenvolvem os projetos do ecossistema? Tem alguma equipe de apoio à gestão que busca contatar e dar suporte aos atores? Se sim, como isso acontece? Possui algum lugar físico ou plataforma onde os atores podem interagir? Há algum controle ou registro sobre as informações compartilhadas e decisões tomadas? Como funciona o processo de tomada de decisão sobre as estratégias do ecossistema?
Práticas de Inovação aberta	Quais são as principais parcerias estratégicas no ecossistema? Quais resultados você percebe?

	<p>Existe resultados que você acredita que as parcerias com outras empresas trouxeram, mas que não é possível mensurá-los? Se sim, cite alguns.</p> <p>Há algum método de coleta para melhoria do ecossistema?</p> <p>Existe uma forma de coleta de ideias/ações externas?</p> <p>Há atores fora do ecossistema que contribuem para o desenvolvimento da rede? Se sim, de que forma?</p>
IA pecuniária (inbound e outbound)	<p>Há compra/venda de conhecimento, licenciamento de produto ou marca que gera royalties para os atores do ecossistema atualmente?</p> <p>Se não há, está no planejamento?</p> <p>Você enxerga essas práticas como importantes?</p> <p>Quais as dificuldades de implementar práticas de venda de <i>know-how</i> na região?</p>
IA não pecuniária (inbound e outbound)	<p>Quais as principais fontes de informação que você percebe que influenciam o ecossistema atualmente?</p> <p>Você contribui enquanto organização/gestão para essas trocas de informação entre empresas? Como?</p> <p>De que maneira as informações impactam o ecossistema e os atores?</p>
Resultados da inovação aberta	<p>Como as parcerias com outras empresas agregam valor para o ecossistema e para a região?</p> <p>Como os processos dentro do ecossistema beneficiam os atores?</p> <p>Você acredita que outras empresas percebem o ecossistema como fonte de informação e oportunidades para o mercado?</p> <p>Quais principais resultados até o momento você pode citar?</p>
Nível de abertura (amplitude e profundidade)	<p>Que tipo de empresas também participam do ecossistema? Há concorrentes diretos?</p> <p>Como é a relação de no ecossistema entre os concorrentes diretos?</p> <p>Que tipo de informação é compartilhada?</p> <p>Quais projetos são desenvolvidos projetos juntos? Cite exemplos.</p> <p>Quais os desafios que é participar de uma rede com outras empresas?</p> <p>Quais os benefícios que você enxerga como participante?</p>
Criação e captura de valor	<p>Como o ecossistema gera valor para os seus atores e para a região?</p> <p>Que tipos de valores são mais comuns até o momento?</p>

c) Roteiro para startups participantes do ecossistema de inovação

Trajatória da empresa	Me conte um pouco de como a empresa foi fundada e como chegou até aqui.
Externalidades da região	<p>Como a região influencia a disponibilidade de recursos?</p> <p>Por que abrir uma startup na Serra Gaúcha?</p> <p>Quais as potencialidades da região que podem ser aproveitadas pela sua empresa?</p> <p>O que você percebe de dificuldades/barreiras na região?</p>
Organização e inovação	<p>Como é a estrutura dos times e departamentos da empresa?</p> <p>Como iniciou a inovação na empresa?</p>

	<p>Você tem uma equipe voltada para pensar inovação na empresa? Como acontecem esses processos?</p> <p>Possui área de P&D?</p>
Práticas de Inovação aberta	<p>Quais são as principais parcerias estratégicas da tua empresa no ecossistema? E fora dele?</p> <p>Quais resultados você percebe?</p> <p>Existe resultados que você acredita que as parcerias com outras empresas te trouxeram, mas que são intangíveis? Se sim, cite alguns.</p> <p>Você costuma participar de reuniões setoriais e associações? Se sim, cite alguns exemplos e periodicidade.</p> <p>Como é o seu envolvimento no ecossistema da Serra?</p> <p>Há algum método de coleta de ideias internas para melhoria do negócio?</p> <p>Existe uma forma de coleta de ideias/ações externas?</p>
IA pecuniária (inbound e outbound)	<p>Você costuma comprar ou vender algum tipo de expertise para parceiros externos? Como conhecimento, licenciamento de produto ou marca que se ganha em royalties?</p> <p>Você enxerga essas práticas como importantes?</p> <p>Se não faz, gostaria de fazer?</p> <p>Quais as dificuldades de implementar práticas de venda de know-how na sua região?</p>
IA não pecuniária (inbound e outbound)	<p>Quais as principais fontes de informação que você percebe que influenciam o seu negócio?</p> <p>Você contribui enquanto empresa para essas trocas de informação entre empresas? Como?</p> <p>De que maneira as informações impactam o seu negócio?</p> <p>Você acredita que parceiros externos podem te fornecer informações valiosas sobre o mercado que impactem positivamente no seu negócio? Cite exemplos.</p>
Resultados da inovação aberta	<p>Como as parcerias com outras empresas agregam valor ao seu negócio?</p> <p>Você acredita já ter se beneficiado de conhecimento de outras empresas? Me conte a sua experiência.</p> <p>Você acredita que outras empresas percebem o seu negócio como fonte de informação para o mercado?</p>
Nível de abertura (amplitude e profundidade)	<p>Você participa de alguma rede de negócios com outras empresas?</p> <p>Que tipo de empresas também participam? Há concorrentes?</p> <p>Como é a relação de vocês em redes que também participam concorrentes diretos?</p> <p>Qual o tipo de informação que vocês compartilham?</p> <p>Vocês desenvolvem projetos juntos? Cite exemplos.</p> <p>Quais os desafios que é participar de uma rede com outras empresas?</p> <p>Quais os benefícios que você enxerga como participante?</p>
Criação e captura de valor	<p>Qual a importância da participação no ecossistema para o desenvolvimento da sua startup? Por quê?</p> <p>O que te agrega participar de uma rede como um ecossistema? O que você busca?</p> <p>Como você percebe que a sua startup agrega para o ecossistema e para a sociedade?</p>

Appendix B – Questionnaire (Paper 3)

Tipo de organização

Como você classifica a principal organização na qual trabalha?

- | | |
|---|---|
| <input type="checkbox"/> organização do governo municipal | <input type="checkbox"/> cooperativa |
| <input type="checkbox"/> organização do governo estadual | <input type="checkbox"/> parque tecnológico, incubadora ou aceleradora |
| <input type="checkbox"/> organização do governo federal | <input type="checkbox"/> startup |
| <input type="checkbox"/> universidade pública | <input type="checkbox"/> instituição de pesquisa e organização da sociedade civil |
| <input type="checkbox"/> universidade privada | <input type="checkbox"/> Outra |
| <input type="checkbox"/> empresa da indústria | |
| <input type="checkbox"/> empresa de serviços | |

Minha organização participa do ecossistema regional de inovação da minha região?

- Sim Não

A. Inovação Aberta em Ecossistemas de Inovação – Alam et al. (2022)								
A1 Confiança interorganizacional	Discordo plenamente		Nem concordo nem discordo		Concordo plenamente		Não se aplica	
	1	2	3	4	5	6	7	9
A1.1 Confiamos que os nossos parceiros estão comprometidos com o que acordamos.	1	2	3	4	5	6	7	9
A1.2 Confiamos nas competências dos nossos parceiros para alcançar os objetivos desejados	1	2	3	4	5	6	7	9
A1.3 Não exploramos as fraquezas dos nossos parceiros de negócios	1	2	3	4	5	6	7	9
A1.4 Protegemos os interesses de todos os parceiros ao tomar decisões de negócios	1	2	3	4	5	6	7	9
A2 Colaboração interorganizacional								
A2.1 Cooperamos com outras organizações para desenvolver novos produtos e serviços	1	2	3	4	5	6	7	9
A2.2 Coordenamos diferentes atividades internas e externas para agilizar as interações comerciais	1	2	3	4	5	6	7	9
A2.3 Desenvolvemos conjuntamente novas soluções viáveis para responder a problemas ou oportunidades	1	2	3	4	5	6	7	9
A2.4 Atingimos objetivos desejados com mais sucesso através de colaborações com outras organizações	1	2	3	4	5	6	7	9
A3 Compartilhamento interorganizacional								
A3.1 Temos acesso aos recursos dos nossos parceiros a baixo ou nenhum custo	1	2	3	4	5	6	7	9

A3.2 Frequentemente compartilhamos conhecimento com os nossos parceiros	1	2	3	4	5	6	7	9
A3.3 Organizamos conjuntamente treinamentos para complementar as habilidades dos parceiros	1	2	3	4	5	6	7	9
A3.4 Compartilhamos experiências de sucesso com os parceiros	1	2	3	4	5	6	7	9
A4 Transparência interorganizacional								
A4.1 Divulgamos detalhes relevantes que são úteis para tomar decisões baseadas em informação	1	2	3	4	5	6	7	9
A4.2 Adotamos procedimentos claros de negócios para evitarmos incerteza sobre a contribuição de cada parceiro	1	2	3	4	5	6	7	9
A4.3 Disseminamos informações em tempo hábil para dar aos parceiros tempo suficiente para reação	1	2	3	4	5	6	7	9
A4.4 Somos muito acessíveis às organizações parceiras para qualquer esclarecimento	1	2	3	4	5	6	7	9
A5 Tomada de risco interorganizacional								
A5.1 Assumimos o risco por confiarmos nos parceiros durante a tomada de decisão	1	2	3	4	5	6	7	9
A5.2 Preferimos atuar em projetos em parceria ao invés da segurança de projetos individuais	1	2	3	4	5	6	7	9
A5.3 Dependemos dos nossos parceiros na implementação de projetos arriscados	1	2	3	4	5	6	7	9
A5.4 Tomamos decisões corajosas para benefícios mútuos	1	2	3	4	5	6	7	9
B. Capacidade de Exploração e Aquisição – Cepeda & Arias Perez (2019)								
B1 Capacidade de Exploração								
B1.1 Nossa organização é proativa em buscar conhecimento externo	1	2	3	4	5	6	7	9
B1.2 Implementamos práticas formais de comercializar nosso conhecimento tecnológico no mercado (patentes, tecnologias, etc.)	1	2	3	4	5	6	7	9
B1.3 Temos uma área responsável pela comercialização dos ativos de conhecimento da empresa com o mercado	1	2	3	4	5	6	7	9
B1.4 Oferecemos ao mercado nosso conhecimento tecnológico ou propriedade intelectual	1	2	3	4	5	6	7	9
B1.5 Frequentemente, exploramos nosso conhecimento tecnológico comercialmente com parceiros e outras organizações	1	2	3	4	5	6	7	9
B2 Capacidade de Aquisição								
B2.1 Frequentemente, adquirimos novos conhecimentos tecnológicos e/ou de mercado de fontes externas para uso dentro da empresa	1	2	3	4	5	6	7	9

B2.2 Regularmente buscamos por ideias externas que permitam a criação de valor para nosso negócio	1	2	3	4	5	6	7	9
B2.3 Há uma sistemática de pesquisa frequente para adquirir tecnologias e propriedade intelectual de fontes externas	1	2	3	4	5	6	7	9
B2.4 Entramos em contato com outras organizações proativamente para adquirir conhecimento tecnológico e comercial e atualizar nossos produtos e serviços	1	2	3	4	5	6	7	9
B2.5 Temos uma tendência a formar mais alianças com outras organizações	1	2	3	4	5	6	7	9
C. Vantagem Competitiva – Alam et al. (2022)								
C1 Inovação								
C1.1 Experimentamos novas ideias e buscamos novas formas de fazer as coisas	1	2	3	4	5	6	7	9
C1.2 Quando se trata de resolver problemas, nós valorizamos novas soluções criativas mais do que soluções de conhecimentos convencionais	1	2	3	4	5	6	7	9
C1.3 A maioria das nossas inovações são baseadas em soluções substancialmente diferentes	1	2	3	4	5	6	7	9
C1.4 A maioria das nossas inovações envolvem conhecimentos ou tecnologias que superam os antigos	1	2	3	4	5	6	7	9
C1.5 A maioria das nossas inovações usam conhecimentos ou tecnologias que tem impactam ou causam mudanças significativas em todo o setor	1	2	3	4	5	6	7	9
C2 Eficiência								
C2.1 A introdução de novos produtos ou serviços aumentou durante os últimos 5 anos	1	2	3	4	5	6	7	9
C2.2 Nós costumamos ser os primeiros no mercado com novos produtos ou serviços	1	2	3	4	5	6	7	9
C2.3 Nós somos rápidos no desenvolvimento de novos mercados	1	2	3	4	5	6	7	9
C3 Responsividade								
C3.1 Nós reagimos rapidamente a necessidade de mudanças nos nossos produtos ou serviços	1	2	3	4	5	6	7	9
C3.2 Nossa linha de produtos/serviços decorrem de uma real necessidade do mercado	1	2	3	4	5	6	7	9
C3.3 Nós usamos menos tempo que nossos concorrentes para responder a mudanças nas políticas regulatórias	1	2	3	4	5	6	7	9
C3.4 Se um grande concorrente lançar uma inovação direcionada aos nossos clientes, implementaríamos uma resposta imediatamente	1	2	3	4	5	6	7	9

C4 Qualidade								
C4.1 Nossos novos produtos/serviços atendem todas as funcionalidades esperadas pelos nossos clientes	1	2	3	4	5	6	7	9
C4.2 Nossos novos produtos/serviços satisfazem todas as necessidades dos clientes	1	2	3	4	5	6	7	9
C4.3 Nossos novos produtos/serviços são de qualidade superior do que os anteriores	1	2	3	4	5	6	7	9
D. Desempenho do Ecossistema – Klimas et al. (2022)								
D1 Inovação								
D1.1 Nos últimos 3 anos, a nossa região apresentou mais oportunidades de apoio à inovação	1	2	3	4	5	6	7	9
D1.2 Nos últimos 3 anos, a nossa região desenvolveu mais conexões entre empresas, governo e universidades	1	2	3	4	5	6	7	9
D1.3 Nos últimos 3 anos, a nossa região tem trazido mais oportunidades de transformação e melhoria dos negócios	1	2	3	4	5	6	7	9
D1.4 Nos últimos 3 anos, a nossa região tem buscado desenvolver uma cultura orientada à inovação.	1	2	3	4	5	6	7	9
D2 Econômico								
D2.1 Nos últimos 3 anos, a nossa região se tornou mais competitiva, gerando maiores ganhos financeiros.	1	2	3	4	5	6	7	9
D2.2 Nos últimos 3 anos, a nossa região gerou maior retorno econômico a partir de parcerias com outras organizações do ecossistema regional de inovação	1	2	3	4	5	6	7	9
D2.3 Nos últimos 3 anos, a nossa região tem tido mais oportunidades de geração de empregos e novos negócios.	1	2	3	4	5	6	7	9
D3 Estratégico								
D3.1 Nos últimos 3 anos, a nossa região tem definido objetivos compartilhados para ganhar notoriedade regional através da inovação.	1	2	3	4	5	6	7	9
D3.2 Nos últimos 3 anos, a nossa região tem estabelecido estratégia mais clara de como se tornar mais competitiva.	1	2	3	4	5	6	7	9
D3.3 Nos últimos 3 anos, a nossa região tem desenvolvido mais ações para fomentar o desenvolvimento tecnológico regional.	1	2	3	4	5	6	7	9
D3.4 Nos últimos 3 anos, a nossa região tem desenvolvido uma identidade regional.	1	2	3	4	5	6	7	9

E. Entrevistado

E1 Qual é o número de funcionários da organização? (indique um número)

E2 Qual é o ano de fundação da organização? (indique um número)

E3 Qual é o principal setor econômico de atuação da organização?

E4 Qual é o município e estado que está localizada a sua organização?

E5 Qual é a faixa de faturamento anual da empresa?

Até R\$ 360 mil

De R\$ 4,8 milhões a R\$ 300 milhões

De R\$ 360 mil a R\$ 4,8 milhões

Acima de R\$ 300 milhões

E6 A empresa vende produtos no mercado externo?

Não Sim. Qual o % do total das vendas?

E7 Há quanto tempo você atua na organização? (indique um número)

E8 Qual o canal que você recebeu o link do questionário?

E-mail

Telegram

LinkedIn

Outro

Whatsapp

E8 Qual é o seu cargo na organização?

E9 Qual é a sua formação?

Ensino Fundamental

Ensino Superior

Ensino Médio

Pós-Graduação

E10 Você gostaria de receber os resultados da pesquisa?

Não Sim. E-mail: