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

Fernanda Kalil Steinbruch

THE ROLE OF TRUST IN THE FOUR DIMENSIONS OF INNOVATION ECOSYSTEMS: IMPLICATIONS FOR INNOVATION PERFORMANCE

Porto Alegre
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Orientadora: Profa. Dra. Daniela Callegaro de Menezes

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ABSTRACT

There are indications that trust is essential to innovation ecosystems relations. However, studies have not yet focused on deeply exploring such connection. The purpose of this study is to comprehend the role of trust among actors in innovation ecosystems and its effect on the actors' innovation performance. To achieve that, this research provides theoretical and empirical insights. Theoretically, it was developed a conceptual model and a set of hypothesis, raising a discussion based on the intertwining of trust and the four dimensions of innovation ecosystems (network collaboration, interdependence, value co-creation and innovation orientation). Then, it was also added the impact of these four dimensions on the actors' innovation performance. Empirically, the model was tested through the structural equation model methodology, centered on four innovation ecosystems located in the south of Brazil. Results showed that trust has a positive influence on network collaboration, interdependence, value co-creation and innovation orientation. Similarly, network collaboration, interdependence and innovation orientation positively influence innovation performance. Value co-creation did not have a positive influence on innovation performance. Additionally, the direct relation of trust on the actors' innovation performance was not supported, indicating the existence of mediating elements. Thus, through the approach of an underexplored area of research, this study sheds light on a broad understanding of the contribution of trust among actors to the development of innovation ecosystems and its effect on the actors' innovation performance.

Keywords: Innovation Ecosystem; Trust; Performance; Actor; Relationship.

RESUMO

Há indícios de que a confiança é essencial para as relações existentes em ecossistemas de inovação. No entanto, os estudos ainda não se focaram em explorar profundamente tal conexão. O objetivo deste estudo é discutir como a confiança entre os atores influencia o desenvolvimento de ecossistemas de inovação e seu efeito no desempenho inovador dos atores. Para conseguir isso, esta pesquisa fornece insights teóricos e empíricos. Teoricamente, foi desenvolvido um modelo conceitual e um conjunto de hipóteses, suscitando uma discussão baseada no entrelaçamento da confiança com as quatro dimensões dos ecossistemas de inovação (colaboração em rede, interdependência, cocriação de valor e orientação à inovação). Em seguida, foi acrescentado também o impacto destas quatro dimensões no desempenho inovador dos atores. Empiricamente, o modelo foi testado por meio da metodologia do modelo de equações estruturais, centrado em quatro ecossistemas de inovação localizados no sul do Brasil. Os resultados mostraram que a confiança tem uma influência positiva na colaboração em rede, na interdependência, na cocriação de valor e na orientação para a inovação. Da mesma forma, a colaboração em rede, a interdependência e a orientação para a inovação influenciam positivamente o desempenho inovador dos atores. A cocriação de valor não teve uma influência positiva no desempenho inovador dos atores. Além disso, a relação direta de confiança no desempenho inovador dos atores não foi sustentada, indicando a existência de elementos mediadores. Assim, com a abordagem de uma área de pesquisa pouco explorada, este estudo traz uma compreensão ampla da contribuição da confiança entre os atores para o desenvolvimento de ecossistemas de inovação e seu efeito no desempenho inovador dos atores.

Palavras-chave: Ecossistema de Inovação; Confiança; Desempenho; Ator; Relação.

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1. Introduction

Innovation is widely recognized by the literature as a driver for economic development and prosperity (Szabo, Ferencz & Pucihar, 2013), mainly because it could create value only through its simpler definition, *i.e*., bringing something new to the market (Schumpeter, 1942). However, customers have been increasingly demanding more from companies, showing that complex innovations require resources that usually involve multiple actors (Adner & Kapoor, 2010). As such, the economic and technological effects of innovation can go beyond the buyer and seller relationship (Granstrand & Holgersson, 2020), especially now that the nature of competition has gone outside the company level.

In this context, many researchers have called attention to the development of innovation not only by one particular company, but by a network of actors (Gomes et al., 2018). This happens because since organizations are becoming more specialized, one single company does not internally have the necessary resources and knowledge for innovation development and implementation (Adner & Kapoor, 2010). The market faced today is characterized by industries with a large number of segments that create numerous goods, services and technologies. For this production to be possible, there is, in those industries, a remarkable level of interaction among multiple players that participate in the design, production, distribution and implementation of goods and services (Iansiti & Levien, 2004). In other words, a company can no longer be considered without its context and must be perceived as being part of a broader environment, known as the innovation ecosystem.

Innovation ecosystem represents "the evolving set of actors, activities, and artifacts, and the institutions and relations, including complementary and substitute relations, that are important for the innovative performance of an actor or a population of actors" (Granstrand & Holgersson, 2020, p. 1). Innovation ecosystems allow firms to create value and deliver solutions that would not be possible if they were alone (Autio & Thomas, 2014; Adner & Kapoor, 2010). This extra value creation is originated through the complementarity of skills and resources that the actors exchange in a collaborative environment (Adner, 2006). Overall, its main purpose is to develop knowledge and innovation through a conjunction of actors, technologies and institutions that collaborate (Aarikka-Stenroos & Ritala, 2017; Adner, 2017). Innovation ecosystems are characterized by having innovation goals and uncertainties related to value creation and capture (Datteé, Alexy & Autio 2017; Ritala et al., 2013), as well as a set of interdependent relations among its actors (Aarikka-Stenroos & Ritala, 2017).

Actors are crucial to innovation ecosystems since they have different strategies and play different roles in these environments (Iansiti & Levien, 2004). For Paasi et al. (2023), actors are one of the key elements of the dynamics of innovation ecosystems. They can be of many types (but not limited to): producers, suppliers, distributors, financial institutions, research institutions, makers of technology and regulatory bodies (Mäkinen & Dedehayir, 2013). The variety of players allows symbiosis and synergistic effects through their interaction and collaboration. Thus, actors are a relevant pillar of innovation ecosystems and can be strongly responsible for their success (Adner, 2006) and for the actors' innovation performance. Innovation performance of innovation ecosystem actors can be considered the outcome of multiple factors that influence the actors' dynamics and activities and represent its innovative results. In addition, there is an absence of studies that discuss the structure of innovation ecosystems and that analyze the interactions among organizations, focusing on its actors (Hakala et al., 2019; Sant'Ana et al., 2020). In fact, advances in the field should make an effort to understand who the actors of innovation ecosystems are and how they interact (Sant'Ana et al., 2020).

It is worth emphasizing that when actors play in the same environment, they may want the same resources, and, consequently, it can represent risks of opportunistic behavior. To mitigate these risks, trust is one of the elements that must be applied in ecosystem relationships (Gulati, 1995). Trust is a valuable mechanism in unpredictable environments, since contracts and formal documents are not enough to comprehend the market dynamics (De Man & Roijakkers, 2008). It is also a key element in uncertainty and innovation driven scenarios (Szabo et al., 2013), such as the ones of innovation ecosystems. This indicates that ecosystem atmospheres require trust, being an important element for its triumph and a crucial factor to innovation networks and to innovation performance (Giest, 2019; Granstrand & Holgersson, 2020; Majava et al., 2016). By collaborating internal and externally, actors can reduce uncertainty in the whole process of innovation and improve innovation performance. This happens because innovation performance can be considered the product of the interaction and reconstruction of multiple groups and elements towards the innovation ecosystem (Zhang & Liu, 2022). Additionaly, there are few studies focused on exploring the influence of ecosystems on innovation performance (Zhang & Liu, 2022).

Therefore, it becomes necessary to comprehend the contribution of trust relations among actors of the innovation ecosystem to the actors' innovation performance. To deepen this analysis, this study will adopt the platform approach of innovation ecosystems, since this

structure facilitates numerous actors' interactions (Kapoor et al., 2021). This approach considers how actors interact around a platform, operating in absence of full hierarchical control (Shipilov & Gawer, 2020). Such conglomerates contribute to collective learning, transaction costs reduction, innovation encouragement, and economic growth. As a consequence, innovation ecosystems build interconnections and interdependencies among its actors that create networks based on a trusting atmosphere and a sense of belonging (Kilduff & Shipilov, 2011; Jacobides et al., 2018).

An initial level of mutual trust is necessary to start the arrangements and settle relations among parties (Hagedoorn, Roijakkers & Kranenburg, 2008), especially because actors can enter and leave the ecosystem at various times, due to its dynamic environment (Dedehayir, Mäkinen & Ortt, 2018). Over time, repeated ties and experiences can increase the level of trust through interactions among the involved players (Giest, 2019). This means that trust follows a progressive process that goes from inter-company trust to a wider trust in the ecosystem and their interconnections (Benitez, Ayala & Frank, 2020).

1.1 Problem delimitation

Innovation ecosystems are composed of interrelated organizations, including firms, government, intermediary agents, research institutes and universities, that are connected through a main organization or a technology platform with the objective to produce innovative goods or services (Adner, 2006; Autio & Thomas, 2014; Carayannis & Campbell, 2009; Gomes et al., 2018). Regarding key themes explored in innovation ecosystems, some authors have focused on studying the value creating process within an ecosystem (Adner & Kapoor, 2010; Gomes et al., 2018; Ritala et al., 2013), while others have focused on showing collaborative arrangements among organizations that contribute to ecosystems (Adner, 2006; Iansiti & Levien, 2004). Recently, studies have been exploring the definitions of innovation ecosystems (Granstrand & Holgersson, 2020), the structure of innovation ecosystems (Sant'Ana et al., 2020), the development of dynamic capabilities in innovation ecosystems (Linde et al., 2021), its relation to social innovation (Carayannis et al., 2021) and the emergence of innovation ecosystems (Pushpananthan & Elmquist, 2022).

Taken as a whole and considering that it can be challenging to develop and implement an innovation alone, one of the main advantages of being part of innovation ecosystems is the existence of firm interdependence to create innovation, in a way that its actors can count on

each other to fulfill their internal lack of resources and knowledge (Adner & Kapoor, 2010; Ritala et al., 2013). As such, previous studies have made so far important advances over the actors of innovation ecosystems (Dedehayir et al., 2018; Lakitan, 2013; Pérez-Nuñes & Serrano-Santoyo, 2020).

However, the literature on this topic remains absent of research exploring *how* the interactions among actors occur (Hakala et al., 2019; Sant'Ana et al., 2020), especially in relation to the existence of trust, which is considered one of the most critical factors of success in collaborative relations (Chesbrough, Kim & Agogino, 2014; Huang & Wilkinson, 2013; Teramoto & Jurčys, 2017). Trust can contribute to increasing the involvement and commitment of parties (Moorman, Deshpandé & Zaltman, 1993), to facilitate information exchange (Sankowska, 2013; Teramoto & Jurčys, 2017) and to reduce risk perception (Mayer, Davis & Schoorman., 1995). This shows that an environment filled with high level trust-based relationships among organizations fosters the emergence of new ideas and innovation (Sankowska, 2013; Teramoto & Jurčys, 2017), which are the basis of innovation ecosystems (Aarikka-Stenroos & Ritala, 2017; Scaringella & Radziwon, 2018).

Even though there are indications that trust may affect innovation ecosystems (*e.g.*, Benitez et al., 2020; Cobben & Roijakkers, 2018; Pattinson, Nicholson & Lindgreen, 2018; Teramoto & Jurčys, 2017), the presented body of studies does not deepen some issues. In this sense, the main question of this research is: **How does trust among actors influence innovation ecosystems?**

To do so, this study is based on three widely known dimensions of trust (ability, benevolence, and integrity) (Mayer et al., 1995), and proposes four dimensions of innovation ecosystems: network collaboration (Adner, 2006; Granstrand & Holgersson, 2020; Hakala et al., 2019; Iansiti & Levien, 2004; Scaringella & Radziwon, 2018), interdependence (Aarikka-Stenroos & Ritala, 2017; Dedehayir et al., 2018; Iansiti & Levien, 2004; Scaringella & Radziwon, 2018), value co-creation (Adner, 2006; Autio & Thomas, 2014; Gomes et al., 2018; Hakala et al., 2019), and innovation orientation (Hurley & Hult, 1998; Lii & Kuo, 2016; Ritala & Almpanopoulou, 2017; Su, Zheng, & Chen, 2018). Additionally, it has been already identified that trust is relevant to innovation performance (Abu El-Ella, Bessant & Pinkwart, 2016; Han & Chen, 2018; Selnes & Sallis 2003; Wang, Tseng & Yen, 2014). Therefore, this research also deepens the understanding of the need of trust to innovation ecosystems and to its actors' performance.

In relation to the context to be analyzed, we used data from the actors of four technological parks in the south region of Brazil. These parks have been seen as mechanisms of local/regional development, through stimulating innovation, competitiveness and organizational performance. Aligned with the sample selection, this research adopted the platform-based approach. This perspective shows that innovation ecosystems allow the complementarities of goods and services via standardized or open interfaces (Gawer & Cusumano, 2014), especially if considered organizations from developing countries that are constantly trying to attract more investors and promote better job opportunities.

By recognizing and improving the role of trust, relationships among actors in innovation ecosystems can be enhanced to generate better innovative results for both the organizations involved, and for the ecosystem as a whole. With that, this study also attends the demands for greater conceptual rigor in innovation ecosystem literature (Granstrand & Holgersson, 2020), as it sheds light on the contributions of trust in innovation ecosystems to the actors' innovation performance, offering a promising opportunity to advance studies in such a field.

1.2 Objectives

In this section, it will be presented the general and the specific objectives of this study.

1.2.1 General objective

To comprehend the role of trust among actors in innovation ecosystems and its effect on the actors' innovation performance.

1.2.2 Specific objectives

a) To identify the dimensions of the innovation ecosystem

b) To build a conceptual model addressing the role of trust in innovation ecosystems' dimensions and its effect on the actors' innovation performance.

c) To analyze how trust is related to the dimensions of innovation ecosystems and to the actors' innovation performance.

1.3 Justification

In the past fifteen years, there has been a growing interest in exploring the innovation ecosystems literature applied to management studies (Gomes et al., 2018; Granstrand & Holgersson, 2020; Hakala et al., 2019; Ritala & Almpanopoulou, 2017; Su, Kajikawa, et al., 2018, Zen et al., 2023), becoming an emerging concept both in academia and industry (Oh et al., 2016; Ritala et al., 2013; Su, Zheng & Chen, 2018). The subject has recently received more attention in disciplines such as strategic management (Adner, 2017; Datteé et al., 2017) and innovation and technology management (Gawer & Cusumano, 2014; Ritala et al., 2013). The field of innovation ecosystems is still in its infancy, building concepts, suggesting tools and developing models to better understand this emerging theory (Rong & Shi, 2015). Consequently, the development of the area requires more advances in empirical work (Suominen, Seppänen & Dedehayir, 2018). It seems that current studies about innovation ecosystems are mostly dedicated to exploring concepts and the way they operate, leaving room for further research on certain aspects of the ecosystems' dynamics (Jacobides, Cennamo & Gawer, 2018; Paasi et al., 2023), such as the actors' interactions and the existence of trust relations among them.

The market that companies face today is becoming increasingly competitive and dynamic, compelling organizations to set collaborative relations in order to operate. These business connections, especially the ones involving long term cooperative relations, consider trust an indispensable element (Morgan & Hunt, 1994), because it reduces the fear of risk and allows organizations to work together (Chams-Anturi, Moreno-Luzon & Escorcia-Caballero 2020; Sankowska, 2013).

The relevance of studying innovation ecosystems in the last few years can also be justified through call for papers from some of the main international journals about innovation: In 2020, Research Policy had a call for papers entitled "Innovation Ecosystems and Ecosystem Innovation"; In 2023, R&D Management had a call for papers entitled "Digital Technologies and Innovation Ecosystems in the Post-Pandemic Era"; and more recently, in 2024, Technovation had a call for papers entitled "Enhancing innovation ecosystems for a sustainable world in times of dramatic change". This contributes to show a significant interest of the academics in studying different aspects of innovation ecosystems and a literature gap in this field. Besides that, it was found that few studies (*e.g.*, Benitez et al., 2020; Cobben & Roijakkers, 2018; Pattinson et al., 2018; Teramoto & Jurčys, 2017) address trust in innovation

ecosystems and the way the relations among actors occur (Hakala et al., 2019; Sant'Ana et al., 2020).

In addition to that, innovation performance is a result of innovation in general (Zhang & Li, 2010). The literature still lacks on knowledge about this topic, since there is room for research on how to "proactively create, steer, and leverage innovation ecosystems for enhanced innovation performance" (Autio and Thomas, 2014, p. 20). Thus, this is also a topic that must be further developed towards the innovation field, and especially applied to innovation ecosystem, because innovation performance constitutes the capacity to transform innovative resources and capabilities into outcomes that lead to innovative market triumph (Abdulai, 2019), which is one of the premises os innovation ecosystems.

It is relevant to study trust among actors in innovation ecosystems because its dynamics require the existence of strong relationships based on mutual collaboration and constant sharing, which is only possible if trust is present in the environment in which actors operate (Giest, 2019; Granstrand & Holgersson, 2020; Paasi et al., 2023).

One of the innovation ecosystems that require high levels of trust and have been significand for the organizations' development and growth in the last few years have been technological parks. Technological parks can be seen as instruments implemented in developed and developing countries to boost regional and national economies, adding know-how. Therefore, such economies become more competitive on the national and international sphere, generating jobs, social well-being and taxes. These parks are usually situated close to universities and educational centers. This happens because such proximity allows synergy and opportunities (Steiner, Cassim & Robazzi, 2008).

Brazil is a country that took longer to explore its technological innovation if compared to other countries, however, it has a good capacity to generate knowledge and it is increasingly exploring its internal talents and resources (Steiner et al., 2008). This helps to justify the sample of this research, *i.e.*, four main technological parks from the south of Brazil.

Therefore, the model proposed by this research contributes to evolve theoretical and managerial foundations of innovation ecosystem field.

In relation to theoretical contribution, this study is justified because it aims to fill a literature gap in the area of management, that is, studies involving trust and innovation ecosystems. It is possible to make this statement based on a search on Scopus and Web of Science databases for studies that contained the words "trust" and "innovation ecosystem" or "innovative ecosystem" in the document's title, abstract or keywords. Only a few articles

appeared to address issues focused on trust and innovation ecosystems (*e.g.*, Benitez et al., 2020; Cobben & Roijakkers, 2018; Pattinson et al., 2018; Teramoto & Jurčys, 2017), leading us to believe that there is room for more comprehensive research in this area.

Regarding managerial relevance, this study contributes to aware managers of the positive impact of trust among actors in the development of innovation ecosystems. Managers must know that trust is essential in interorganizational relations to achieve successful innovation. With that in mind, they can start training their staff – even before entering the ecosystem - to develop such type of relation with their partners. They must also use the information presented here to create effective trust building tools in a short period of time, which is what the dynamic of the ecosystems demands. Moreover, the innovation ecosystem as a whole can also benefit from this research. It is argued that for an ecosystem to succeed and develop, the involved actors must be well managed and be based in trustworthy relationships. In intense and aggressive environments that organizations face today, being able to trust a partner to jointly create innovation can be a real competitive advantage. Thus, developing trust relations among partners in innovation ecosystems is imperative to reduce risks of opportunism among actors.

1.4 The structure of the study

This study is structured as follows. First, in this introductory chapter, it was presented the context of the study, the research question, its general and specific objectives, and the justification for the study. In the second chapter, the theoretical background, it was investigated the concepts of innovation ecosystems, synthesizing its main features, its main actors and identifying key dimensions addressed in the literature. It was also explored innovation performance and the definitions of trust and its dimensions. In the final part of the theoretical background chapter, it was proposed a conceptual model involving trust and innovation ecosystems. The third chapter details the methodological procedures adopted in this research. In this section, it was presented the research characterization, the research design and the detailing of the research steps. The fourth chapter consists of the data analysis and discussion of the results. Finally, the fifth chapter is dedicated to the final considerations and conclusions of this research.

2. Theoretical Background

In this chapter, it will be presented the main academic literature that supports this research. First, it is presented the central features of innovation ecosystems through its concepts and dimensions. It is also addressed the actors of such environment based on the quadruple helix, and their innovation performance, followed by the platform approach of innovation ecosystems. Next, it is described the concepts of trust and its dimensions. In the end of this chapter, it is proposed a conceptual model addressing trust and innovation ecosystems.

2.1 Specifying traits of Innovation Ecosystems

Different types of ecosystems are sometimes used interchangeably in the literature (Gomes et al., 2018; Gupta, Mejia & Kajikawa, 2019; Scaringella & Radziwon, 2018), especially when considering business ecosystem (Moore, 1993), entrepreneurial ecosystem (Prahalad, 2005) and innovation ecosystem (Adner, 2006). It is true that they have common features. Some of them are the structure of interdependent network of actors (Scaringella & Radziwon, 2018); the existence of cooperation and competition among ecosystem's actors (Gomes et al., 2018; Stam, 2015; Valkokari, 2015; Zen et al., 2023); the dynamics of a co-evolution process (Moore, 1993); and the tendency to center the ecosystem on a key actor, that can be a large firm, a policy maker or a platform owner (Hakala et al., 2019). However, since ecosystems also have different kinds of interactions, it is important to distinguish them in order to expand these areas of research and consolidate the knowledge associated to each ecosystem (Gomes et al., 2018; Valkokari, 2015).

The ecosystem term applied to management field was first coined by Moore (1993), when he realized that networks and interorganizational relations should not only be analyzed through an individual bias, but mostly through a broader conceptual level. This culminated in the definition of **business ecosystem**, which is composed of interdependence and collaborative effort of multiple actors by interconnected networks of sharing knowledge, skills, and resources (Moore, 1993). Based on an economic perspective, business ecosystems are more related to value capture, strategy, and performance (Gomes et al., 2018), since the main purpose is to create connections and induce ecosystem collaboration (Hakala et al., 2019).

Entrepreneurial ecosystem, in its turn, concentrates more on policy and structures that can support the formation of the ecosystem and the set of its individual elements, namely

culture, capital markets and open-minded customers (Isenberg, 2010). Its driving force is based on regional development (Hakala et al., 2019), characterized by the promotion of job creation, gross domestic product (GDP) growth and high rates of entrepreneurship in a specific region (Isenberg, 2010; Scaringella & Radziwon, 2018; Stam, 2015).

Unlike the two types of ecosystems described above, the main goal of **innovation ecosystem** is to create innovation, through an innovation oriented environment (Granstrand & Holgersson, 2020; Ritala & Almpanopoulou, 2017). Its specific traits include working in symbiosis (Dedehayir et al., 2016; Valkokari, 2015), managing the ecosystem collaborations and enhancing value co-creation, since few organizations by their own are capable of having all the necessary resources to produce innovation (Adner, 2006; Hakala et al., 2019). Adner (2006) indicates that the logic of innovation ecosystems is based on coevolution and shared risk among multiple actors.

Therefore, innovation ecosystem is associated with joint value creation and with its succeeding outcomes of new technologies, new product development and new process development (Adner & Kapoor, 2010; Gomes et al., 2018), which enable highest innovation performance and trust (Davis, 2016).

Given that the definitions of innovation ecosystems highlight collaboration (Granstrand & Holgersson, 2020), they can be considered "collaborative arrangements through which firms combine their individual offerings into a coherent, customer-facing solution" (Adner, 2006, p. 2). In this sense, goods and services are developed through network collaboration of suppliers, distributors, technology providers and product providers that are usually located close to one another, either geographically or cognitively (Hakala et al., 2019; Iansiti & Levien, 2004; Scaringella & Radziwon, 2018). An external network, such as the one in innovation ecosystems, allows organizations to identify and develop new opportunities, providing synergistic benefits along with innovation (Spriggs et al., 2013). Besides that, network collaboration is beneficial to firm performance (Sorenson, Folker & Brigham, 2008). Because of these synergistic relations of people, knowledge and resources, ecosystems present different architectural models, structures, and ways of internal collaboration, resulting in several interdependencies that can determine its outcomes and its success (Adner & Kapoor, 2010; Su, Zheng, & Chen, 2018).

Such interdependence occurs among actors, technologies and institutions. In interdependence, members of a group interact and depend on each other to realize certain job (Campion, Medsker, & Higgs, 1993), in a way that multiple asset providers and customers need

each other and act in a complementary way (Aarikka-Stenroos & Ritala, 2017; Autio & Thomas, 2014; Campion et al., 1993). Likewise, when analyzing different roles played by members of the innovation ecosystem, Dedehayir et al. (2018) emphasize the dynamic interdependence of those roles. Based on mutual assistance (Gobble, 2014), interdependencies can be of various types and include heterogeneous interconnected pieces and participants, such as organizations, technologies, individuals, and institutions (Adner, 2006; Ritala & Almpanopoulou, 2017). Consequently, these intense interactions and links allow the optimization and motivation of collective contribution (Campion et al., 1993), facilitating processes of sharing knowledge and value co-creation (Iansiti & Levien, 2004).

Innovation ecosystems center its focus on value co-creation, which is the proof that the major contribution of innovation ecosystems is not a particular good or service, but rather a variety of interrelated technologies and organizational competencies, resources and skills that combine to co-produce the demands of a particular society (Autio & Thomas, 2014; Gomes et al., 2018). In this manner, actors jointly create value through their complementarity of resources that few organizations could perform alone (Aarikka-Stenroos & Ritala, 2017; Adner, 2006; Gomes et al., 2018).

The coordination and management of these co-created values seek to achieve innovation objectives, which represent the main goal of innovation ecosystems (Autio & Thomas, 2014; Hakala et al., 2019; Ritala et al., 2013; Ritala & Almpanopoulou, 2017). The existence of innovation as the final goal is the driver of innovation-oriented environments. Innovation orientation can be defined as a corporate culture that encourages its members to create, to contribute and to experiment new ideas that rapidly meet market demands (Hurley & Hult, 1998; Lii & Kuo, 2016). It is not just the intention to be innovative, but also having the necessary structure to develop innovation, the operational-level behaviors that influence a market orientation and the environment to accomplish innovation objectives (Dobni, 2010). These organizations "devote their energy towards innovation – that is inventing and refining superior products, services, and communications" (Berthon, Hulbert & Pitt, 2004, p.1065).

Table 1 summarizes the central dimensions of innovation ecosystems, its definitions, and the corresponding literature. These four dimensions were suggested based on the specific characteristics of innovation ecosystems that appeared most frequently in the leading articles of the field. Additionally, they constitute the result of the specific objective *a* of this study.

Table 1. Dimensions of Innovation Ecosystems

Dimension	Concept	Conceptual basis
Network collaboration	A set of connected parties aiming to achieve their own objectives and also collective ones.	Adner (2006); Granstrand & Holgersson (2020); Hakala et al. (2019); Iansiti & Levien (2004); Scaringella & Radziwon (2018).
Interdependence	Two or more parties that depend on each other for product or process accomplishments.	Aarikka-Stenroos & Ritala (2017); Dedehayir et al. (2018); Iansiti & Levien (2004); Scaringella & Radziwon (2018).
Value co-creation	Two or more parties that jointly create value through mutual collaboration.	Adner (2006); Autio & Thomas (2014); Gomes et al. (2018); Hakala et al. (2019).
Innovation orientation	The culture of encouraging and achieving innovation goals.	Autio & Thomas (2014); Dobni (2010); Hurley & Hult, (1998); Ritala & Almpanopoulou (2017); Su, Zheng, & Chen (2018).

Considering that innovation ecosystems involve many types of actors and links (Su, Kajikawa, et al., 2018), shown by its peculiarities of network collaboration, interdependence, value co-creation, and innovation orientation, they represent an environment filled with mutual dependence and high uncertainty level (Scaringella & Radziwon, 2018). As such, uncertainty and risks are intrinsic elements of relationships based on interdependence and collaboration, demanding that organizations rely on others to achieve their objective (Mayer et al., 1995). Although innovation ecosystem literature still lacks studies about these interactions and exchanges (Hakala et al., 2019), some researchers already identified the need of building relationships based on trust (Gobble, 2014; Scaringella & Radziwon, 2018).

This is because trust is fundamental to interactions (Sankowska, 2013) and to achieve success in collaborative relations (Teramoto & Jurčys, 2017), which start with the presence of a mutual need (Basterretxea, Charterina & Rodríguez, 2019). Trust is considered an informal mechanism to coordinate ecosystems, in a way that it affects its evolution and facilitates productive operation of networks (Autio & Thomas, 2014). When establishing trust-based ecosystems, it becomes easier to achieve cooperation, stimulate sharing, and disseminate ideas, information and, consequently, innovation (Teramoto & Jurčys, 2017). Hence, in order to

understand the existing interactions among actors of innovation ecosystems, it becomes essential to explore trust relations in such circumstances (Teramoto & Jurčys, 2017). Since these relations occur among players of innovation ecosystems, in the following subsection, the actors of such an environment are defined and exemplified.

2.1.1 Determining the actors of innovation ecosystems

Innovation ecosystem actors are active players of the environment that collaborate and co-create to achieve innovation objectives. They can be of multiple types, consisting of end users, customers, communities, developers, research organizations, competitors, institutions and complementors of the entire network (Adner & Kapoor, 2010). In order to set the group of actors to be analyzed in this study, it is used the quadruple helix model, which considers the interactions of academia, government, industry and civil society (Carayannis & Campbell, 2009; Miller et al., 2016). In general, the helix approach highlights the interaction among multiple actors towards co-creating, sharing knowledge and resources and developing new technologies.

Table 2 shows some of the actors that are part of the quadruple helix model, which were considered for this study.

Table 2. Actors of the quadruple helix

Helix	**Actors**
Academia	Universities, higher education institutions, higher education system, research centers.
Government	Government agencies, regulatory bodies, accrediting bodies, political system, development banks.
Industry	Firms, startups, technological parks, incubators, accelerators, investors.
Civil Society	End users, customers, professionals and companies that support innovation, leaders, popular icons, entrepreneurs.

The actors of innovation ecosystems are usually part of a society and of an environment that allows cooperation among them. Many of these players are set in agglomerations, which

can also bring benefits to their innovation performance (Aarikka-Stenroos & Ritala, 2017; Davis, 2016). For this reason, the next subsection brings the discussion over innovation performance of the innovation ecosystem's actors.

2.1.2 Innovation performance of the innovation ecosystem's actors

A crucial result of innovation is innovation performance, which is a multidimensional variable (Zhang & Li, 2010). The literature still have some gaps about knowledge on the drivers of innovation performance (Adner & Kapoor, 2010; Autio & Thomas, 2014; Oh et al. 2016). As pointed out by Autio and Thomas (2014, p. 20), little is known about how to "proactively create, steer, and leverage innovation ecosystems for enhanced innovation performance". Therefore, innovation performance has been a topic of interest in recent business studies, especially because its association with economic growth (Charterina et al. 2016). It can be defined as the outcome of an innovation process comprising the development and the implementation of innovation activities (Chen & Huang, 2009). In other words, it is the capacity to transform innovative resources and capabilities into outcomes that lead to innovative market triumph (Abdulai, 2019). In sum, innovation performance is a result of many influencing factors and represents the achievements and results obtained from innovation.

Deepening the concept of innovation performance, it can be distinguished the narrowly defined innovation performance and the generalized one (Hagedoorn and Cloodt, 2003). The narrowly defined innovation performance is related to the commercialization level of firms' technology creation. The generalized innovation performance refers to patents, technical improvements, and innovation outcomes. Innovation performance can also be classified according to the perspective of efficiency and effectiveness. The efficiency dimension includes innovation speed, such as new product development and launch speed. The effectiveness dimension comprises innovation outputs and effects, such as patents, new products, sales growth, investment returns, competitive advantage and customer satisfaction.

Innovation performance can be increased through the collision of knowledge and technologies from multiple organizations, which enhances knowledge flow (Robertson et al., 2021). In fact, higher innovation performance of economies progressively depends on knowledge (Carayannis & Campbell, 2009) and it is created due to the integration of knowledge, skills, and competencies from different players in innovation contexts (Vyakarnam and Handelberg, 2005).

In the context of ecosystems, this shows that achieving market success also depends on the efforts of other innovators in the environment (Aarikka-Stenroos & Ritala, 2017). It can be said that innovation performance is influenced by the capacity to interact with the environment (Chiu, 2009) and with its knowledge-sharing habits (Charterina, Basterretxea & Landeta, 2016). It is shown that, to reach superior innovation performance in innovation ecosystem environments, the actors "should possess the ability to create or generate new knowledge, diffuse it through its ecosystem, and expediently transform the newly acquired knowledge into new technologies or processes for competitive advantage" (Robertsonet al., 2021).

The existence of interdependencies among innovation ecosystem actors lead to new perspectives as to how to co-create value in order to achieve higher innovation performance (Adner & Kapoor, 2010). In such context of ecosystems, the interaction among its actors depends on knowledge. In fact, one of the biggest drivers of innovation performance is knowledge creation, sharing and absorption (Robertson et al., 2021), and this is one of the premises in the dynamics of innovation ecosystems. Additionally, more collaborative ways of acting, such as sharing databases, discussing ideas, are positively related to innovation performance. In innovation ecosystems these practices are common and frequently part of the actors' daily routines. In the same line, Zhang & Liu (2022) argue that the environment can strongly influence the organization's innovation performance and the stronger the support to innovation, the higher is the organization's innovation performance.

Innovation performance consists of product innovation and process innovation. Product innovation concentrates on market and customers, while process innovatio focuses on the firm's internal processes and efficiency (Utterback & Abernathy, 1975). Since this study analyzes a dynamic and external environment (innovation ecosystems), it is more appropriate to adopt the concept of innovation performance as product innovation (Brown & Eisenhardt, 1995; Zhang & Li, 2010; Zhang & Liu, 2022). Therefore, innovation performance will be investigated as the outputs, the effect and the speed of innovation through innovation products (OECD, 2018; Sun et al., 2021).

In order to evaluate the innovation performance of innovation ecosystems, it is crucial to consider its structural approach. This study is in line with the platform-based approach, which will be detailed next.

2.1.3 Innovation ecosystem as a platform

Literature shows that there are two main approaches of innovation ecosystems: platforms and territories. Platform approach focuses on relationships with a hub firm, while territorial approach emphasizes inter-organizational relationships mainly across the territory (Zen et al., 2023). This study is centered on the platform approach of innovation ecosystems.

The platform-based approach is centered on a platform that intermediates the contributions among the actors of innovation ecosystems, generating value (Zen et al, 2023) and allowing the maximization of the actors' objectives (Gawer & Cusumano, 2014; Mukhopadhyay & Bouwman, 2018). In other words, a platform-based innovation ecosystem constitutes a scenario in which there is a central pivot, which can be a leading organization, that guides other actors to find solutions and to contribute to the development of the ecosystem as a whole (Tsujimoto et al., 2018). Thus, the platform orchestrates, co-ordinates or regulates the ecosystem (Jacobides et al., 2018; Lütjen et al., 2019; McColl-Kennedy, Cheung & Coote, 2020).

This study adopts the platform approach because it is focused on innovation ecosystems such as technological parks, which are defined as structures that propose significand actions and solutions for the constant changes towards globalization and the new knowledge society (Spolidoro & Audi, 2008). This arrangement promotes value co-creation through the interaction of networks and collaboration between the leading organization and the innovation ecosystems' actors, being an open platform of interconnections (Autio & Thomas, 2014; Dedehayir et al., 2018; Jacobides et al., 2018). Platform structure is becoming popular especially in innovative businesses, such as Amazon, Apple, Facebook and Microsoft, in which their value propositions are built on digital platforms (Kapoor et al., 2021).

Academics point out a few characteristics of platform-based ecosystems. One of them is *platformization*, *i.e.,* the possibility of the leading firm to offer a platform in which other actors can exchange resources, technologies and knowledge (Gomes et al., 2018). This platform is also characterized by an open environment that connects many participants (Dedehayir et al., 2018; Kapoor et al., 2021) from different backgrounds, allowing the existence of diversity in the ecosystem (Moore, 1996). In such atmosphere, complementarity of resources and capabilities becomes mandatory to allow the ecosystem to prosper (Iansiti & Levian, 2006). Another characteristic is *modularity*, which is essential to bring flexibility to any system (Cenamor, Sjödin & Parida, 2017). This happens because the platform remains the same, while the modules change in order to generate different outputs (Zhong & Sun, 2020). *Complexity* is also present in platform-based ecosystems, since the interdependent modules interact. With that

in mind, the more modules interact, higher is their interdependence, which will result in greater platform complexity (Cennamo, Ozalp & Kretschmer, 2018).

It is important to mention that the literature mostly classifies platforms in two categories: internal (or company-specific) and external (or industry-wide). In internal platforms, the exchanges of skills and resources take place within the company, allowing the recombination of subunits inside this single company (De Reuver, Sørensen & Basole, 2018; Gawer & Cusumano, 2014). This platform's innovativeness is based on the company's own capabilities (Gawer & Cusumano, 2014). In external platforms, organizations that do not necessarily participate in any joint transactions are brought together, become interdependent and must operate synergistically as a part of a technological system (Gawer & Cusumano, 2014). Therefore, considering this classification, the external type of platform is more appropriate to this study.

Since these interactions of actors occur industry-wide, within multiple actors, they probably know little about each other and need more relations of trust and commitment in order to do business together. It makes it pertinent to also explore the definition of trust and its dimensions, applying this knowledge to the one of innovation ecosystems studied so far.

2.2 Defining trust and its dimensions

As an attempt to conceptualize trust, Mayer et al. (1995, p. 712) defined it as "the willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party". In simple terms, trust can be described as a willingness to assume risks (Mayer et al., 1995), with an expectation that the other party will act in a fair, ethical (Chams-Anturi et al., 2020) and benevolent way (Welter, 2012). Trust is dynamic: it shifts and evolves over time according to interactions among parties, which means that it can also be easily lost, particularly due to its fragility and to the propensity of being vulnerable to another party (Bstieler, Hemmert & Barczak., 2017; Barney & Hansen, 1994; Huang & Wilkinson, 2013; Majava et al., 2016; Mayer et al., 1995; McKnight, Choudhury & Kacmar, 2002; Teramoto & Jurčys, 2017; Welter, 2012). Because of its strong relation with credibility, trust is the base for any business connection (Majava et al., 2016) and a source of competitive advantage (Barney & Hansen, 1994). Trust motivates stable relationships, contributes to knowledge transfer and facilitates the communication of ideas (Chams-Anturi et al., 2020).

Based on the exposed definitions, it is understood that trust is essential to boost innovation (Sankowska, 2013), to reduce risks and to achieve success in collaborative interorganizational relations (Bstieler et al., 2017; Chams-Anturi et al., 2020). In these collaborative links, several organizations cooperate with partners and create network relations in order to achieve common objectives (Donati, Zappalà & González-Romá, 2019). In short, trust plays an important role in business relationships, since its presence can effectively and efficiently allow knowledge transfer among different parties (Massaro et al., 2019) and even enhance the network performance (Cobben et al., 2023; Klijn et al., 2015). Thus, environments where organizations collaborate with each other and establish interdependent networks require interorganizational trust (Donati et al., 2019; Sharafizad & Brown, 2020), which can be considered the driver of exchange relations, negotiation, and conflict (Donati et al., 2019; Zaheer, McEvily & Perrone, 1998).

Trust in organizational level has received recent attention from some researchers (*e.g.,* Chams-Anturi et al., 2020; Donati et al., 2019), who recognized the relevance of trust in interorganizational relationships (Seppänen et al., 2007). According to Gulati and Nickerson (2008, p. 689), "if the partner firm fulfills positive expectations, the focal firm develops greater confidence in the partnership, and this confidence in turn mitigates future concerns about opportunism". From the basics, trust allows organizations to work together (Chams-Anturi et al., 2020), because it represents a critical element in the beginning of a new business (Welter, 2012) and it attenuates the fear of risk, helping to maintain collaboration alliances (Sankowska, 2013). Going further, well-built bonds of trust between organizations can even increase business performance (Barney & Hansen, 1994; Chams-Anturi et al., 2020; Zaheer et al., 1998) and enhance companies' innovativeness through knowledge transfer among collaborating members (Sankowska, 2013). These bonds are usually characterized as strong ties, which represent a combination of emotional components, amount of time, intimacy, and reciprocal services (Granovetter, 1973). Strong ties between the trustor and the trustee can raise the level of trust, and that is why it is important to set clear roles in the connections of these parties (Bstieler et al., 2017; Seppännen et al., 2007). Nevertheless, building trust among organizations can be a challenging task (Seppännen et al., 2007), especially when these actors are part of innovation ecosystems.

In this sense, there are some critical factors that affect trust building in inter-organizational relations (Kobayashi, Hara & Usui, 2017), such as similarities in educational processes, in decision processes, in demographic backgrounds and in communication (Bstieler

et al., 2017). Moreover, specific dimensions of the trustee must also be considered to determine the level of trust between parties (Fulmer & Gelfand, 2012; Mayer et al., 1995), such as reliability (Aulakh, Kotabe & Sahay, 1996; Dyer & Chu, 2000; Smith & Barclay, 1997; Zaheer et al., 1998), predictability (Young-Ybarra & Wiersema, 1999; Zaheer et al., 1998), fairness (Dyer & Chu, 2000; Zaheer et al., 1998), dependability (Smith & Barclay, 1997; Young-Ybarra & Wiersema, 1999), goodwill (Dyer & Chu, 2000; Sako & Helper, 1998) and honesty (Chow & Holden, 1997; Smith & Barclay, 1997). However, the trust dimensions considered in this study are those defined by Mayer et al. (1995), that have been the most frequently cited in the literature of trust: ability, benevolence, and integrity.

Ability is the combination of skills, competencies and characteristics that allows a party to have influence over other parties, being determinant on trust (Mayer et al., 1995). Competence and expertise are also used in the literature as correspondents of ability (Colquitt, Scott & LePine, 2007). Ability varies based on the context and on the exchange partners involved (Koh, Fichman & Kraut, 2012). In other words, because it presupposes the competence of the trustee in some technical domain, ability is very specific, which means that the trustee can have notable ability in one area and less experience in another area, causing different perceptions of trust (Mayer et al., 1995). Generally, ability-based trust is considerably fast to reach, since it is not built on emotional interactions (Jeffries & Reed, 2000).

Benevolence is when it is identified that, leaving aside egocentric motives, the trustee is willing to do good to the trustor, in a way that parties are motivated to achieve mutual gains (Doney & Cannon, 1997; Mayer et al., 1995). Benevolence is the disposition to cooperate with partners even when not required, in a way that it facilitates other's job (Callens & Bouckaert, 2019). It is related to the trustee's concern about the trustor's well-being (Koh et al., 2012), also being referred to as caring, openness and loyalty (Colquitt et al., 2007). In relations of trust based on benevolence, there is an attachment between the parties involved and, consequently, lower is the motivation for them to lie to each other, reducing uncertainties, risk, and opportunism (Koh et al., 2012; Mayer et al., 1995). In sum, this dimension of trust corresponds to good intentions of both parties, since they take into consideration the partner's interest in the exchange relationship.

Finally, integrity constitutes the trustor's perceptions that the trustee follows similar principles and rules (Mayer et al., 1995; McKnight et al., 2002). It includes the trustee's former actions, sense of justice, reliable communications and congruence between actions and words (Mayer et al., 1995). Having integrity is also associated with a partner's discreetness,

professionalism, honesty, responsibility (Callens & Bouckaert, 2019). So, when integrity-based trusted parties act, they are guided by honesty and socially accepted standards and principles (Ridings, Gefen & Arinze, 2002; McKnight et al., 2002). It is based on the belief that a trustee is dependable and reliable (Jarvenpaa, Knoll & Leidner, 1998) and that the trustor is being considered a priority (Callens & Bouckaert, 2019). In a way, this dimension includes consistency, fairness, justice, and reliability (Fulmer & Gelfand, 2012), being important to build trust especially in the beginning of a relationship (Mayer et al., 1995).

The next table summarizes the dimensions of trust and its main corresponding literature.

Table 3. Dimensions of Trust

Trust Dimension	Concept	Conceptual basis
Ability	The combination of skills, competencies and characteristics that allows a party to have influence over other parties, being determinant on trust.	Colquitt, Scott & LePine, 2007; Jeffries & Reed, 2000; Koh, Fichman & Kraut, 2012; Mayer et al., 1995;
Benevolence	The disposition to cooperate with partners even when not required, in a way that it facilitates other's job.	Callens & Bouckaert, 2019; Doney & Cannon, 1997; Koh et al., 2012; Mayer et al., 1995;
Integrity	The trustor's perceptions that the trustee follows similar principles and rules.	Callens & Bouckaert, 2019; Mayer et al., 1995; McKnight et al., 2002;

In order to generate trust in innovation ecosystems context, it is suggested to explore ability, benevolence and integrity, deepening ways to build a strong trustworthy environment that allows the generation of innovation. This leads to the development of a conceptual framework and supporting hypotheses.

2.3 Towards a comprehensive framework

It is well known in the literature that trust is an essential component to any business connection, especially to develop and maintain long term cooperative relations (Morgan & Hunt, 1994). Having a trust-based relationship makes parties want to establish a high-level commitment and to stay connected (Donati et al., 2019). This can also be said over innovation ecosystems, in which actors mutually compete and collaborate in order to co-create innovation. As such, most actors play, simultaneously, the role of the trustee and of the trustor in multiple relations. High levels of trust among actors in innovation ecosystems contribute to a better relation and a more efficient sharing of ideas and innovation (Teramoto & Jurčys, 2017), indicating that trust is a fundamental component for the ecosystems' success (Chesbrough et

al., 2014). However, despite the aforementioned recognition that trust is crucial in defining effective and reliable innovation ecosystems, limited efforts have been done to explore the relevance of trust in this type of environment.

Analyzing existing research that addresses trust and innovation ecosystems allows the demonstration of the uniqueness of the proposal of this study. Benitez et al. (2020) examined how innovation ecosystems can evolve and how value is co-created, adopting the social exchange theory – which includes trust, commitment, reciprocity, and power. Cobben and Roijakkers (2018) sought to understand how governance mechanisms are used by a focal entity to influence partner alignment and mitigate risks of opportunistic behavior in innovation ecosystems. These governance mechanisms include trust and control. Teramoto and Jurčys (2017) explore the role of intermediaries in sharing information in innovation ecosystems. They state that mutual trust contributes to diminish transaction costs and enable new opportunities to exchange information.

Overall, these studies explore elements involving a particular phenomenon (*i.e.,* social exchange theory, governance mechanisms and intermediary's role), not specifically focusing their research on trust. Different from that, Pattinson et al. (2018) developed a contingency framework that synthesizes the main trust building factors adopted by organizations in innovation ecosystems (*i.e.,* degree of novelty, protection of innovation, propensity for added value, propensity for risk, and previous success of networks). Since this study has the most similar approach to the present one, it is believed that, following a continuous path, after building trust, it is also important to analyze how trust among actors is related to the dynamics of innovation ecosystems. To what has been known, no research has done that so far. The proposed conceptual framework presented in the end of this section (Figure 1) represents an attempt to go over that issue. In the following subsections, it is examined how trust is related to the four dimensions of innovation ecosystems and it is also proposed a relation with the actors' innovation performance. These associations are further explained in more detail.

2.3.1 The relevance of trust on network collaboration

Much of the actors' motivation to be part of a network is the possibility to obtain missing knowledge and expertise that other members might have. In fact, many network relations are built based on an actor's collaboration of skills and knowledge (Shazi et al., 2015). These competencies refer to the ability dimension of trust, which includes skills and technical domain

(Mayer et al., 1995). In a network context, ability can be identified as the perceived capacity of members to deliver what they have promised and with a satisfactory quality (Palmer & Huo, 2013).

In these circumstances, actors tend to be strongly concerned about their partners (Shazi et al., 2015), which is the essence of benevolence: the prominence of kindness and willingness to do good to others (Mayer et al., 1995). When parties "agree to forgo the right to pursue their own interests at the expense of others" (Powell, 1990, p. 303), they are part of a network collaboration.

Furthermore, if members of a network play with integrity, conflicts and misunderstandings can be drastically reduced (Massaro et al., 2019). It can be said that integrity in network relations implies that the members involved act honestly and have the same perception of how and in which way the exchanged information should be used (Dogbe et al., 2020; Massaro et al., 2019; Mazzola et al., 2015; Mayer et al., 1995). Integrity is the organizations' willingness to behave ethically (Palmer & Huo, 2013), suggesting that actors in innovation ecosystems with moral principles and rules can be trustworthy.

Having this said, it is notable that trust can encourage the exchange of information and knowledge in network collaboration (Klijn et al., 2015). Besides that, high levels of trust among network actors lead to successful interfirm connections and increase the willingness to help each other in producing innovation (Lane, Salk & Lyles, 2001; Wang & Chen, 2012). The previous reflections are summarized in the following hypothesis:

Hypothesis 1. Trust positively influences network collaboration

2.3.2 The relevance of trust on interdependence

Because of specialized expertise, ability allows one party to influence others (Mayer et al., 1995), creating interdependence. In this systemic context of innovation ecosystems, organizations not only exchange information in a collaborative way, but they build dependent relations with partners because of their skills, that is, their ability.

The benevolence dimension of trust prevents actors from playing opportunistically. Due to the need for complementary resources in innovation ecosystems, partners know that they need each other to accomplish individual (and collective) goals. This leads to interdependence, in which actors depend on their partners and become more exposed to risks and uncertainties

(Gomes et al., 2018). In trust-based relationships, when parties take other actors' pursuits into consideration (Rousseau et al., 1998), they are acting benevolently.

When interdependence is based on integrity, partners can avoid additional costs, such as controlling, that saves them from explaining what type of information can be shared (Massaro et al., 2019). To achieve common goals, organizations try to depend on partners that have similar ethical and moral values.

Interdependent relations built on trust can incite coopetition among parties, by nurturing cooperation and competition at the same time (Chai, Tangpong & Clau, 2019), which is a typical attribute of innovation ecosystems. Thus, depending on trustworthy partners can optimize the functioning of any business relation. These arguments contribute to the formation of the second hypothesis:

Hypothesis 2. Trust positively influences interdependence

2.3.3 The relevance of trust on value co-creation

When two or more parties engage in interdependent relations, sharing unique and complementary resources, there is a tendency that they co-create value (Ferm & Thaichon, 2021; Piantoni, Arena & Azzone, 2023; Sheth, 2019). This shows that the essence of value co-creation is based on the organizations' ability, being a fundamental dimension to trust in this kind of activity. By synchronizing each member's collaboration, such as knowledge, skills and information, the actors of innovation ecosystems cooperate towards a common outcome. Besides that, if organizations have a high level of ability recognized by the market, other organizations can start feeling motivated to trust them and embark on relations of value co-creation (Fawcett et al., 2017).

Further, the existence of benevolence is implied and mandatory in value co-creation relationships, and, consequently, in innovation ecosystems. More than in any business relation, in value co-creation, parties must look for others' interests, because they happen to be the same. As such, if an institution achieves a particular goal by jointly creating value, its partners are too reaching their own objectives. The outcome and the benefits of this kind of activity are shared among the participants (Fawcett et al., 2017; Yaghmaie & Vanhaverbeke, 2019). Therefore, the success of innovation ecosystems also depends on the partners' commitment in creating value together (Yaghmaie & Vanhaverbeke, 2019).

Likewise, even though it might not be the most important trust dimension in value co-creation, integrity must also be considered. To explore the unique potential of value co-creation, collaborators must align their interests and goals (Fawcett et al., 2017), meaning that they must have similar beliefs about behavior and principles.

Altogether, trust is a necessary condition to a successful value co-creation (Lei et al., 2020; Shulga et al., 2020). The creation of value, by its turn, is a fundamental aspect of economic exchange (Prahalad & Ramaswamy, 2004; Vargo, Maglio & Akaka, 2008), which is essential to innovation ecosystem dynamics. These arguments lead to the succeeding hypothesis:

Hypothesis 3. Trust positively influences value co-creation.

2.3.4 The relevance of trust on innovation orientation

Activities that promote innovation also need ability-based relations in which the trustor believes that the trustee has competence to provide relevant contributions. Particularly when involving innovation objectives, ability can be strategic for establishing initial trust in technology-based organizations (Palmer & Huo, 2013). In short, the partner's ability will result in new ideas and products (Giest, 2019), being one of the basic principles of innovation orientation.

Benevolence is also relevant for innovation orientation. With an altruistic approach, this dimension of trust can be a predictor of idea generation and implementation (Shazi et al., 2015). It can previously show if partners are motivated to achieve mutual gains (Doney & Cannon, 1997; Mayer et al., 1995), which is critical to establish an innovation orientation dynamic. Overall, benevolence can be considered the commitment of a party to provide helpful information to other parties (Massaro et al., 2019). This is a common (and desirable) practice in innovation ecosystems, allowing actors to build trust in partners that care about their business and their innovation goals.

In general, for successful innovation to flourish, partners should focus on integrity and mutual trust (Zhu, Habisch & Thøgersen, 2018). Integrity is particularly important when choosing a partner to work with (Shazi et al., 2015). When it is recognized by the market that actors are endowed with integrity, they are aligned with each other and tend to adhere to

identical principles. This way, the achievement of innovation objectives also becomes easier, because it considers the actors' congruence of values.

Innovation-oriented organizations value long term relationships (Lii & Kuo, 2016). In this sense, innovation-oriented organizations with trust relations are constantly encouraged to find efficient ways of doing business, as a result of its continuous innovative effort (Mohedano-Suanes, Revilla-Camacho & Garzón, 2021). Therefore, the following hypothesis is:

Hypothesis 4. Trust positively influences innovation orientation.

2.3.5 The relevance of innovation ecosystem dimensions on innovation performance

The first innovation ecosystem dimension identified in this study is network collaboration. Previous studies have already emphasized the association between network collaboration and innovation performance (Gulati, Lavie & Madhavan, 2011; Luo, 2022; Sorenson et al., 2008; Spriggs et al., 2013; Sun et al., 2021).

Innovation activities structured in network collaboration among organizations can create opportunities, reduce obstacles in promoting knowledge sharing and information sharing, improve resource utilization efficiency, and, as a result, improve innovation performance (Zhang & Liu, 2022). Greater innovation performance occurs because of the integration of knowledge, skills, and competencies of different parts in innovation activities (Vyakarnam & Handelberg, 2005). Besides that, more networking experiences (Mokhtarzadeh et al., 2020) and closer relationships with partners (Sun et al., 2021) will generate higher performance. In an innovation ecosystem environment, this is only possible due to the interaction and exchanges among the actors.

Therefore, because of the integration of knowledge, skills, and competencies, network collaboration allows organizations to have a broader resource synergy to create innovation, which will lead to better innovation performance. Thus, hypothesis 5 is presented:

Hypothesis 5. Network collaboration positively influences the actors' innovation performance.

Network collaboration is closely related to interdependence, because when the degree of interdependence is high, parties must work interactively to achieve a common objective.

According to Saavedra, Earley & Van Dyne (1993) interdependence is the extent in which the behavior of one party influences the performance of other parties. It considers how much different parties must work together with the purpose of achieving their objectives. With interdependence, there is more resource support from the parties involved, so it contributes to increasing the rate of idea implementation (Zhang & Li, 2021).

Mutual dependence of two or more parties also intensifies solidarity and cooperation in a business relationship (Provan, 1994), as well as the shared understanding of interactive behavior, which leads to mutual benefits (*e.g*. Batsakis et al., 2018). This will nurture joint actions, bring mutual trust and generate a high level of commitment to the relationship, which is essential for knowledge sharing (Gulati & Sytch, 2007). Hence, shared understanding, mutual trust, joint actions and high commitment originated from interdependence are the necessary mechanisms to create innovation. And the results of innovation are what constitute the organizations' innovation performance (Abdallah, Dahiyat & Matsui, 2019; Luo, 2022; Zeng, Phan & Matsui, 2015)

Innovation ecosystems have a high degree of interdependence. In contexts like this, there is also a high degree of interaction among actors who support each other in providing the necessary resources for creating innovation (Zhang & Li, 2021). Consequently, innovation generation will lead to greater innovation performance. Considering this, the succeeding hypothesis arises:

Hypothesis 6. Interdependence positively influences the actors' innovation performance.

Because of network collaboration and interdependence, actors can co-create in innovation ecosystem environments, leading to the third dimension: value co-creation. This dimension shows that organizations not only share resources, but they actually collaborate with each other through value co-creation (Wong et al., 2016). It reflects the interactive activities of innovative processes (Zhang & Chen, 2008).

Previous studies have already affirmed that co-creation has a positive and significant impact on innovation performance (Baraldi, Gressetvold & Harrison, 2012; Dahlin et al., 2020; Otchere et al., 2019; Stock, Zacharias & Schnellbaecher, 2017; Tsou, Chen & Yu, 2019; Westerlund & Rajala, 2010). Co-creation enables organizations to access better opportunities for learning, and more possibilities for cooperation. This leads to the combination of new and existing knowledge, which allows organizations to create new ideas. As a result, innovations

originated from co-creation among two or more parties contribute to their innovation performance (Dahlin et al., 2020).

Due to the configuration and functioning of an ecosystem, its actors are constantly co-creating value with each other, through the combination of their expertise and resources (Gnyawali & Srivastava, 2013). These collaboration activities contribute to product and service innovation (Baraldi et al., 2012; Moore, 1993; Westerlund & Rajala, 2010) and when an actor co-create within its own ecosystem, it increases the actors' innovation performance (Tsou et al., 2019). Considering the foregoing, it is proposed the following hypothesis:

Hypothesis 7. Value co-creation positively influences the actors' innovation performance.

The three dimensions explored so far can only have a positive effect on the innovation ecosystem if its actors cherish and emphasize innovation orientation. Innovation orientation presupposes a culture that promotes openness to new ideas (Hurley & Hult, 1998), encourages creativity and the search for innovation, stimulating employees to explore promising innovative opportunities (Abdallah, Dahiyat, Matsui, 2019).

Some empirical studies have already indicated that innovation orientation has a positive effect on innovation performance (Ayoub, Abdallah, & Suifan, 2017; Aalbers & Dolfsma, 2015; Lii & Kuo, 2016; Shehadeh et al., 2016; Whelan et al., 2011), especially because it provides the organization the necessary skills and resources to constantly innovate (Siguaw, Simpson, & Enz, 2006). These tools help to enhance the implementation levels of new ideas (Hurley & Hult, 1998) and generate innovation outcomes (Pscheidt-Gieseler et al., 2018), which directly influence innovation performance (Abdallah, Dahiyat, & Matsui, 2019; Siguaw et al., 2006). Therefore, the proposed hypothesis is presented next:

Hypothesis 8. Innovation orientation positively influences the actors' innovation performance.

2.3.6 The relevance of trust on innovation performance

Trust is vital to innovation (Abu El-Ella et al., 2016). It is helpful in solving knowledge sharing problems of innovative processes (Gilsing & Nooteboom, 2006) and a necessary component in the organization's effectiveness and success (Han & Chen, 2018).

In interorganizational settings, trust can create collaborative atmospheres that foster innovation through the increase of quantity and quality of information flows. Institutions that do not invest in trust relations can miss out opportunities to save costs, or to develop organizational capabilities that are necessary to achieve their innovation objectives (Molina-Morales, Martínez-Fernández & Torlò, 2011).

A high level of trust among organizations maximizes the effects of knowledge sharing, enabling them to learn, interact with each other and create new ideas, which directly affect the improvement of innovation performance (Abu El-Ella et al., 2016; Han & Chen, 2018; Selnes & Sallis 2003; Wang et al., 2014). Thus, organizations that are in environments based on mutual trust - such as innovation ecosystems - are more willing to share and absorb knowledge from each other without many fears and to have higher innovation performances. Based on this, the following hypothesis arises:

Hypothesis 9. Trust positively influences the actors' innovation performance.

The following table summarizes the hypotheses suggested in this study:

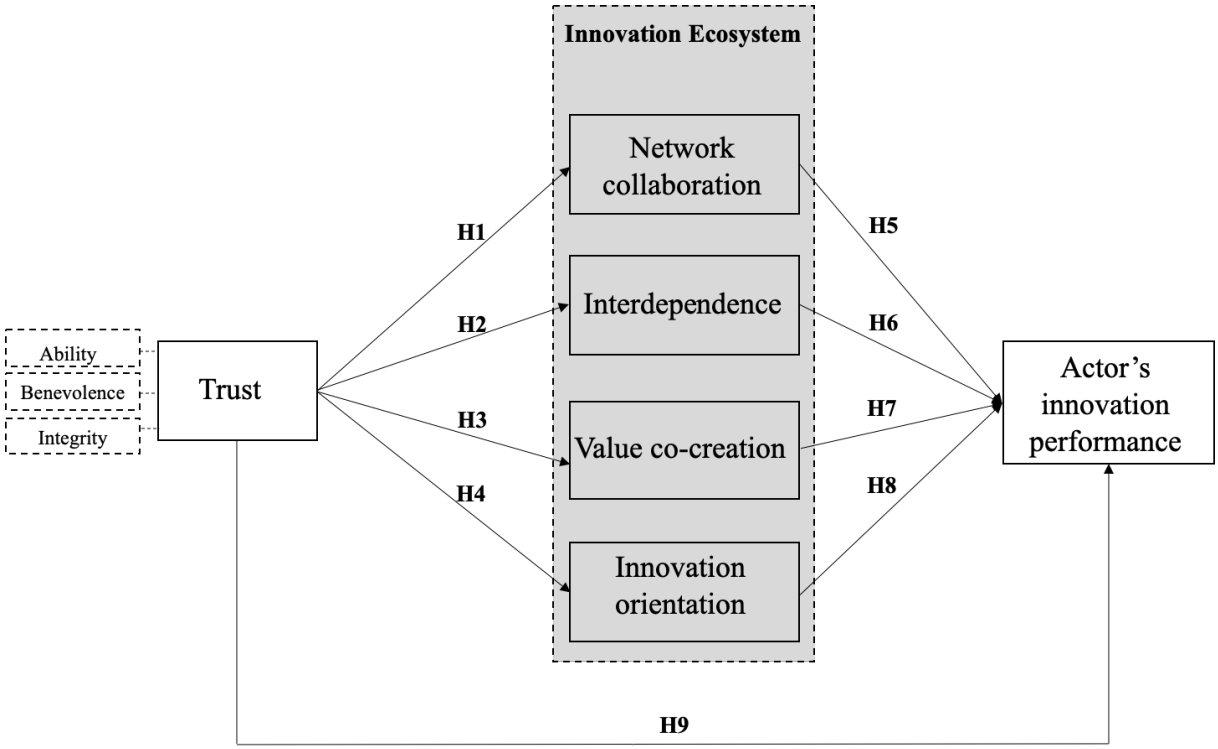
Table 4. Hypotheses

Hypothesis 1	*Trust positively influences network collaboration*
Hypothesis 2	*Trust positively influences interdependence*
Hypothesis 3	*Trust positively influences value co-creation*
Hypothesis 4	*Trust positively influences innovation orientation*
Hypothesis 5	*Network collaboration positively influences the actors' innovation performance*
Hypothesis 6	*Interdependence positively influences the actors' innovation performance*
Hypothesis 7	*Value co-creation positively influences the actors' innovation performance*

Hypothesis 8	*Innovation orientation positively influences the actors' innovation performance*
Hypothesis 9	*Trust positively influences the actors' innovation performance*

Applying the dimensions of trust (Mayer et al., 1995) to the circumstances of innovation ecosystems suggests that ability refers to the actors' capacity to perform their job, with appropriate skills and knowledge. Benevolence represents the actor's concern about their partner's business, helping each other to achieve common goals. Lastly, integrity is associated with the belief that the actors of innovation ecosystems will keep their promises, due to common principles. Based on these assumptions and on the hypotheses mentioned above, the conceptual framework (Figure 1) was built.

Figure 1. Trust in innovation ecosystems



Note. H = hypothesis

Source: the author.

For these hypotheses to be evaluated and tested, it will be presented a research method that enables the empirical verification of its validity, as well as the achievement of the objectives of this study.

3. Methodological procedures

This chapter presents the methodological procedures used in this study to achieve its objectives and to answer the research question. Section 3.1 presents the research characterization. Section 3.2 consists of the research design. And section 3.3, along with its subchapters, covers the details of all the research stages.

3.1 Research characterization

This research can be classified as exploratory, being used on little-known problems. According to Churchill (1999), the five main applications of exploratory research are in the following cases: (i) elaboration of problems in a more precise way of investigation or for formulating hypotheses; (ii) definition of future research priorities; (iii) search for information on practical issues regarding research execution; (iv) greater knowledge of the researcher about the topic of interest; and (v) definition of concepts. Items (i) and (iv) are the ones that are most in line with this study.

In order to investigate the methodology used in existing studies of innovation ecosystems, it was first searched in the main databases (Scopus and Web of Science) studies involving innovation ecosystems as the main topic. The methodological section of these articles was analyzed and most of them indicate that qualitative methodology (especially case studies) is the most frequently used to investigate this topic. Likewise, Gomes et al. (2018) state that much of the research on innovation ecosystems consists of theoretical-conceptual work and case studies. However, it is unlikely that the understanding of innovation ecosystems advance solely based on case studies, which commonly adopt a single-actor approach and make it difficult to generalize results (Hakala et al., 2019; Majava et al., 2016). Therefore, to expand knowledge about the dynamics of innovation ecosystems, the present research uses a quantitative methodology.

The study is also characterized by its descriptive nature, adopting a detailed approach of the characteristics of the investigated phenomenon, which is trust among actors in innovation ecosystems (Malhotra, 2001). In addition to describing the characteristics of certain groups, the descriptive research analyzes the proportion of the population that behaves in a specific way and makes unique predictions, in order to determine the frequency in which social phenomena occur (Churchill, 1999).

The literature already indicates the need for quantitative research in the area of ecosystems, suggesting this methodology for future studies (Ritala et al., 2013; Scaringella & Radziwon, 2018). According to Sampieri, Collado and Lucio (2006), the quantitative method allows the researcher to test hypotheses through numerical measurements and statistical analysis, in order to establish patterns of behavior in the sample of the study. Additionally, the interactions and relationships of actors in the ecosystem can benefit if analyzed through quantitative studies that apply formal metrics (Aarikka-Stenroos & Ritala, 2017).

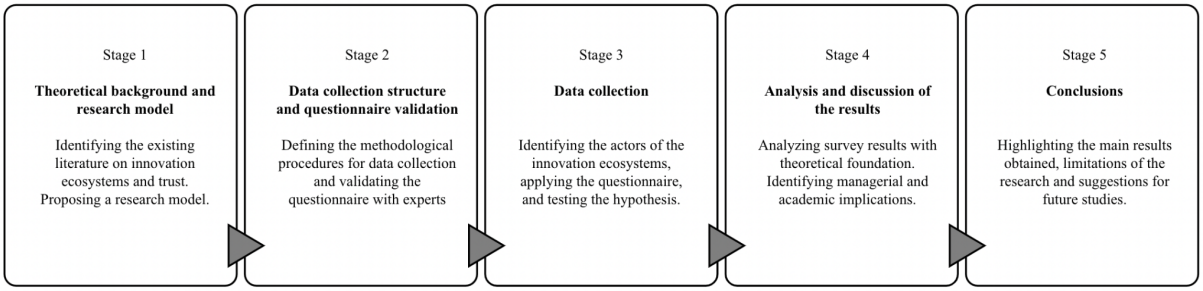
Regarding the epistemological positioning of the study, a positivist approach was adopted. This perspective has been widely used in management studies (Oliveira et al., 2018), in which the researcher's position is as distant as possible, observing and collecting data that can be replicated in a future study (Lincoln, Lynham & Guba, 2005). That is, when collecting and analyzing data, researchers adopt the position of observers of reality (Collis & Hussey, 2009). Related to the positivist positioning, this study has a deductive logic, which is based on an applied theory to observe a specific phenomenon based on hypotheses that can be rejected or not rejected (Leão, Mello & Vieira, 2009).

3.2 Research design

The research was developed in five stages. The first stage consisted of developing the theoretical background for formulating the research model (framework). The second stage consisted of defining the structure of data collection and validating the study questionnaire. In the third stage, data collection took place. The fourth stage comprises the analysis and discussion of the results. Finally, the conclusions of the study are in the fifth stage, highlighting the main results obtained, as well as limitations and suggestions for future studies.

The research design is represented in Figure 2.

Figure 2. Research design



Source: the author.

3.3 Details of the research steps

In this section, the research steps illustrated in Figure 1 will be detailed, in order to provide transparency of the methodological process and allow the study to be replicated.

3.3.1 Development of the theoretical background and research model

In the initial stage of the study, the theoretical background was developed. In January 2021, a search was carried out in the main databases used in management (Scopus and Web of Science) in order to identify existing academic studies about the relationship between innovation ecosystems and trust. These databases are recognized for providing relevant publications in reliable journals (Caputo et al., 2019; Sassetti et al., 2018). The terms used for search were "innovation ecosystem" OR "innovative ecosystem" AND "trust". Only four articles (*e.g.*, Benitez et al., 2020; Cobben & Roijakkers, 2018; Pattinson et al., 2018; Teramoto & Jurčys, 2017) addressed trust in innovation ecosystems at that time. Therefore, it was found that there is still room to explore the topic. Subsequently, having obtained greater detail on the studied concepts, there was also a need to research the concept of innovation performance, due to the relationship with the themes presented above. The terms surveyed in databases were "innovation performance" OR "innovative performance". The search was limited to the title, abstract and keywords.

Resulting from the theoretical background of the present study, the research model represents the conceptual construction of this thesis. The process of developing the research model included the explanation of the concepts used, nine hypotheses and the proposed framework. This framework represents one of the deliverables of this study, defined in the specific objective *a*.

The research model presents an independent variable (trust), four mediating variables (network collaboration, interdependence, value co-creation and innovation orientation) and one dependent variable (innovation performance). The independent variables (also called predictors, antecedents or exogenous) are used to explain a certain effect on the study. The dependent variables (explained or endogenous) are those that represent this effect (Kerlinger, 1980). Finally, the mediating variables represent a mechanism in which an independent variable affects a dependent variable of interest (Baron & Kenny, 1986).

3.3.2 Structuring quantitative data collection

Since the quantitative method was considered the most appropriate for this study, it was decided to implement a survey. The survey is basically characterized by the following aspects: (i) collection of quantitative data about a specific focus; (ii) direct questioning of people belonging to the analyzed population; and (iii) data collection with a portion of the population, called sample (Pinsonneault & Kraemer, 1993). The actions taken to implement the empirical phase of this thesis will be further explored.

3.3.2.1 Population and sample characterization

Considering that this research seeks to understand the role of trust among actors in innovation ecosystems, it is essential to select one or more ecosystems and their actors. The innovation ecosystems chosen as a background for this study are the main scientific and technological parks located in the southern region of Brazil: Feevale Techpark (Feevale), Tecnopuc (PUC), Tecnosinos (Unisinos) and Zenit (UFRGS). Technological parks were used as the sample of this research mainly for two reasons: (i) because they are considered innovation ecosystems; and (ii) because they are somehow responsible for promoting and managing the interactions among its actors, aiming to improve the synergy of such environments and promote the scientific and technological development of the region. Therefore, since the present study is dedicated to analyze the relation of trust among actors of innovation ecosystem, this sample shown to be appropriate to achieve the research objectives.

In each ecosystem, the relationships among its actors and the relevance of trust for the actors' innovation performance were analyzed. The main objective of a science and technology park is to foster links between scientific and business communities, allowing the combination of multiple knowledge and skills. This integration results in a culture of innovation, competitiveness and intense sharing of knowledge and technology. It also encourages the creation and development of technology-based companies through incubators and spin-offs (Pompermaier & Prikladnicki, 2020).

One of the reasons for choosing these technology parks as innovation ecosystems was due to the economic, political, and social characteristics of the location where they are installed, in Rio Grande do Sul. The region is strategically located in relation to MERCOSUR and has

large business, scientific and technological development perspectives (Pompermaier & Prikladnicki, 2020).

Feevale Techpark is focused on scientific and technological cooperation and provides support to consolidated or startup companies, public, private or mixed organizations. The park is integrated into Feevale's structure and its main objective is to bring the university closer to companies, encouraging technology transfer, business competitiveness and the promotion of new businesses, products, processes and services. This ecosystem had its first initiatives in 1998 and today it has three units, an incubator and multiple actors (Feevale Techpark, 2023).

Tecnopuc is a science and technology park founded as an initiative of Pontifícia Universidade Católica do Rio Grande do Sul (PUCRS) with the goal of increasing the number of cooperative projects of Research, Development and Innovation (RD&I) with industry partners, stimulating innovation and entrepreneurship, mainly around the university campus. Tecnopuc's main objectives are (i) to attract technological research and development projects; (ii) to stimulate innovation and company-government-university interaction; and (iii) to generate positive synergy between academia and companies (Pompermaier & Prikladnicki, 2020; Tecnopuc, 2023).

Tecnosinos, Unisinos' technology park, aims to generate new technology ventures, driven by innovative entrepreneurs, and to encourage the sustainable development of the region. It was created 20 years ago and nowadays it has national and international actors involved, generating more than BRL 2.5 billion and 120 registered items of intellectual property (Tecnosinos, 2023).

Zenit is the name of the scientific and technological park of the Universidade Federal do Rio Grande do Sul (UFRGS). The ecosystem began operating in 2012 with the objective to promote the university's research, innovation and entrepreneurship system through new ideas that transform the productive sector and bring innovative products and services to society. Zenit operates on three pillars: entrepreneurial training, incubation and open innovation (Zenit, 2023).

Due to the General Data Protection Law (LGPD), technology parks do not provide a contact list of their actors. Therefore, we sought to identify the actors of each ecosystem through technology parks' websites. E-mail and telephone contacts were obtained through these websites. Some of them did not exist anymore or are no longer part of the ecosystem. It was identified 65 actors from Feevale Techpark, 175 actors from Tecnopuc, 50 actors from Tecnosinos and 53 actors from Zenit.

In order to define the required number of the sample for the study, it was used the G*Power software, version 3.1 (Faul et al., 2009). To guarantee a minimum recommended sample value, the number of predictors of the dependent variable, the power of the test and the effect size (f^2) were evaluated. Based on the minimum parameters indicated by Hair et al. (2014), 0.80 was adopted as test power and 0.15 for the effect size (f^2), for 5 predictors. Thus, the estimation of the minimum sample presented by the software was 92 respondents (Appendix 8).

Regarding the respondents' profile for the research, the survey was sent to directors and managers of each actor in the four ecosystems. This choice was made because we sought to focus on the trust relationships that exist between actors, therefore, respondents needed to understand the dynamics of the ecosystem relationships and be a part of it.

3.3.2.2 Data collection instrument

A questionnaire (Appendix 7) was the data collection instrument chosen for the research. We sought to test the proposed theoretical model and obtain information about trust among actors in innovation ecosystems and the consequent innovation performance of the actors. The questionnaire was translated from English to Portuguese and verified with back-translation (Brislin, 1980; Malhotra, 2001). The procedure was implemented as follows: first, a native portuguese-speaking translator translated the English questionnaire to Portuguese. The result of this translation was translated again to English (the questionnaire's original language) by a native english-speaking translator. This technique is applied to make the equivalence of constructs in different cultures (Malhotra, Agarwal & Peterson, 1996), since the scales used were originally in English and the questionnaire of this study is in Portuguese.

The questions were structured based on a 5-point Likert scale, with 1 being "totally disagree" and 5 being "completely agree". The data collection instrument was constructed based on the orientation and details of the research variables and associated with scales for each of these variables.

First, the Free and Informed Consent Form (in Portuguese, *Termo de Consentimento Livre e Esclarecido* - TCLE) was presented to provide clarifications about the study to respondents. After the respondent agreed to participate in the survey, the questionnaire was presented. Initially, questions of characterization were presented: area of activity, time of existence, time of operation in the ecosystem and the number of employees. Next, we described

the main actors of an ecosystem, in order to equalize the respondents' understanding of the concept *actors*.

The questionnaire was structured based on 31 questions distributed among the constructs of the theoretical model: trust (11), network collaboration (3), interdependence (3), value co-creation (3), innovation orientation (6) and innovation performance (5).

The survey items used to measure trust (Appendix 1) were adapted from the already existing scale by McKnight et al. (2002). The authors developed and validated trust measures applied to e-commerce, which requires initial trust from the parties involved without knowing each other in advance. The same occurs in environments such as innovation ecosystems: actors generally have little or no prior interaction with each other and end up doing business together. Regarding the dimensions of the ecosystem, to measure network collaboration, the scale for collaborative networks by Sorenson et al. (2008) was adapted, described in Appendix 2. To measure interdependence (Appendix 3), the study considered the interdependence scale used by Campion et al. (1993), which captures the extent to which the work of one party depends on another party (Le Blanc, González-Romá, & Wang, 2021). On the value co-creation scale (Appendix 4), which was adapted from Dahlin et al. (2020), this study adopts a definition based on collaboration, being appropriate for inter-organizational contexts (Ramaswamy & Ozcan, 2018; Bharti, Agrawal & Sharma, 2015). To measure the organization's innovation orientation, we used the scale adapted from Lii and Kuo (2016), based on Hurley & Hult (1998); Zhou et al. (2005); Chen & Huang (2009); Siguaw et al. (2006), shown on Appendix 5. Finally, to measure innovation performance, the scale by Zhang and Li (2010) was adapted, which can be found in Appendix 6.

After the questionnaire was ready, it was validated with experts in order to identify its suitability regarding the research theory, the technical capacity to operationalize the research, the understanding of the content and its validity (Malhotra, 2001). At this stage, five experts in innovation ecosystems validated the questionnaire: three managers from organizations and two university professors. Thus, it was possible to make some adjustments in order to make some questions clearer and more concise. After validation, the questionnaire was applied.

3.3.3 Data collection

Regarding the data collection and the questionnaire application stage, a pretest was initially carried out, so that a preliminary analysis of the developed research model could be

done. The application of the pre-test aims to identify and eliminate possible difficulties in the data collection instrument, in addition to confirming the understanding of the questioned content and its validity (Malhotra, 2001). In the pre-test stage, six questionnaires were administered. The pre-test result was considered satisfactory, authorizing the data collection procedures and the inclusion of these answers in the final database. Therefore, data collection for the study continued based on the same procedures, which are detailed below.

A first contact was made via email to the actors of each ecosystem (Feevale Techpark, Tecnopuc, Tecnosinos and Zenit) in order to explain the objective of the research and to identify which professional from the organization would be the most appropriate respondent towards achieving the objective of the study. This technique, called key informants, consists of choosing to speak to a specific individual in the organization whose position or knowledge allows us to obtain more appropriate answers (Bagozzi, Yi & Phillips, 1991). After the organization informed the most appropriate respondent, a link with the online questionnaire (in Google Forms tool) was sent to the respondent. Online surveys via e-mail or the internet makes it possible to obtain quick answers with low operational costs (Malhotra, 2006; Schonlau, Fricker, & Elliott, 2002). Moreover, it is possible for respondents to complete the questionnaire when it is most convenient for them (Malhotra, 2006). In a second moment, new emails were sent and calls were made as reminders to complete the questionnaire, with the aim of increasing the number of responses obtained.

Regarding the moment of data collection, the intersectional model was used, which means that data were collected at a certain moment for each participant of this sample. Therefore, the results obtained reveal the respondents' perception of the topic at the time of data collection (Babbie, 1999).

In total, 121 valid questionnaires were obtained. Data collection took place between June 14th, 2023 and August 1st, 2023.

3.3.4 Analysis and discussion of the results

This section presents the statistical treatment of data obtained from the research. Initially, in the pretest stage and in the complete study, some analyses were necessary to verify the characteristics of the database, using descriptive statistics. Later, in the predictive and confirmatory analysis of the research model, as well as in the tests of hypotheses, it was used

structural equation modeling with partial least squares estimation (PLS-SEM). To run PLS-SEM, we use the software SmartPLS version 3.0.

3.3.4.1 Sample analysis through descriptive statistics

At this stage, the 121 valid responses were analyzed, based on descriptive statistics tools. The data were extracted from Google Forms and tabulated in a Microsoft Excel spreadsheet version 16. This tabulation is relevant on coding variables and on enabling statistical analyses.

Descriptive statistics were also used to analyze the items measured though five-point Likert scale. Thus, data on mean, median and standard deviation of the constructs are also provided.

3.3.4.2 Sample analysis through partial least square structural equation model (PLS-SEM)

The analysis was based on the theoretical model of this study with the goal to analyze the extent in which trust among actors in innovation ecosystems impacts the innovation performance of ecosystems' actors. This way, the hypotheses of the proposed model were tested (Figure 1). The PLS-SEM allows analyzing observed and latent variables, which distinguishes it from other statistical techniques, such as analysis of variance (ANOVA) and multiple regressions, which analyze observed variables, admitting only one relationship between the dependent and independent variables (Kline, 2011). These aforementioned restrictions do not occur with structural equation modeling, since it allows the analysis of various relationships between measurable variables (indicators) and latent variables (dependent or independent).

The PLS-SEM technique was adopted in this study for a few reasons: (i) to test a more complete theoretical model, involving multiple constructs; (ii) to better understand the increasing complexity of the topic, exploring theoretical extensions of existing theories; (iii) when a small population restricts the sample size; (iv) when there is no need to impose normal distribution assumptions on the data; and (v) to carry out exploratory work that seeks to find and evaluate causal relationships (Hair et al., 2014). Additionally, PLS-SEM is a suitable analysis for testing new theoretical relationships, while the covariance-based structural equation model (CB-SEM) is more applicable for testing a theory (Hair, Ringle & Sarstedt,

2011). Another reason to adopt PLS-SEM is that this method is appropriate for evaluating models that include theoretically justified cause and effect relationships (Hair et al., 2019), as it is summarized in the theoretical model of this research (Figure 1). Similarly, Bido and Silva (2019) emphasize that PLS-SEM is suitable in situations in which the theory that supports causal relationships is not yet strongly consolidated and can be used in a more exploratory way. Having this said, and given the objectives of the research, the PLS-SEM method proved to be the most appropriate one.

Before running the PLS-SEM model, some evaluations were performed, which will be described hereafter. The Kolmogorov-Smirnov and Shapiro-Wilk tests were also carried out in SPSS (Hair et al., 2022). These tests compare the scores of a sample with another that has a normal distribution, and both indicated that the data from this research do not present a normal distribution ($p < 0.05$).

The common method bias (CMB) was also analyzed, since data on exogenous and endogenous variables were obtained from the same respondents, in the same way of collection (survey) and during the same period of time. The CMB could lead to underestimation or overestimation of structural coefficients. Therefore, using SPSS, Harman's single factor test was applied, which simultaneously analyzes the entire database combined in factor analysis without rotation (Podsakoff et al., 2003). Values resulting from the test that are below 50% are considered adequate and free from method bias problems. Regarding the present study, the test showed that the majority of the covariance explained by one value was 36.29%, which indicates absence of method bias problem.

The interpretation process through PLS-SEM encompasses the analysis of the structural and measurement model, which connects the constructs through relations and logic. It was performed the following analyses:

Table 5. Measurement and structural model

Measurement model	**Structural model**
Loadings	*Test of hypotheses*
Internal consistency reliability (Cronbach's Alpha, rho_a; Composite Reliability)	*Quality criteria (R^2, Q^2 e VIF)*
Average Variance Extracted (AVE)	*Additional test (indirect effects; mediation effects)*
Discriminant validity (Fornell-Larcker; HTMT)	

In the measurement model, the indicator loading (or factor loading) must initially be analyzed. Loadings above 0.5 are recommended (Dorce et al., 2021).

Internal consistency reliability was also evaluated using Cronbach's Alpha, rho_a and composite reliability. Cronbach's Alpha is a coefficient that indicates the internal consistency of the constructs (Hair et al., 2019). A Cronbach's Alpha above 0.7 is considered ideal (Hair et al., 2019) and above 0.6 is considered adequate (Steenkamp & Vantrijp, 1991).

The rho_A coefficient is a construct reliability measure that is situated generally between Cronbach's Alpha and composite reliability (Dijkstra & Henseler, 2015). It is suggested to be above 0.7, but values above 0.6 are considered acceptable for exploratory research (Hair et al., 2019). For Composite Reliability, values between 0.60 and 0.70 are classified as acceptable; values between 0.70 and 0.90 are considered satisfactory; and values greater than 0.95 are problematic - it indicates that the construct's items are redundant (Hair et al., 2019).

Another step in the measurement model is the analysis of the convergent validity of each construct. This analysis seeks to verify how much the construct converges to explain the variance of its items. For this, the average variance extracted (AVE) is the method used. According to Hair et al. (2019, p. 9), “to calculate the AVE, one has to square the loading of each indicator on a construct and compute the mean value”. When the AVE value is equal to or above 0.5, it indicates that the construct has variance explanation power, revealing that the construct is capable of explaining at least 50% of the variation of its items (Hair et al., 2019; Hair et al., 2020).

Still in the analysis of the measurement model, it was performed the analysis of the discriminant validity, which is used to measure the distinctiveness of a construct (Hair et al., 2020). It is analyzed using two criteria: Fornell-Larcker and HTMT. The Fornell-Larcker criterion indicates that the square root of AVE must be greater than the construct correlations. The HTMT (heterotrait-monotrait ratio of correlations) “is defined as the mean value of the item correlations across constructs relative to the (geometric) mean of the average correlations for the items measuring the same construct” (Hair et al., 2019, p. 9). An HTMT value equal to or greater than 0.9 indicates sufficient evidence of discriminant validity (Hair et al., 2020). The following table represents the methods used to create the measurement model.

Table 6. Analyses to perform the measurement model

Analysis	Method	Values of reference	Source

Indicator reliability	Factor loading	≥ 0.50	Dorce et al., (2021)
Composite reliability	Cronbach's Alpha	> 0.60	Steenkamp and Van Trijp (1991)
	rho_a	> 0.60	Hair et al. (2019)
	Composite Reliability	≥ 0.60 and < 0.95	Hair et al., (2019)
Convergent validity	AVE	≥ 0.50	Hair et al., (2019)
Discriminant validity	Fornell-Larcker criterion	Compares the square roots of the values of the AVEs of each construct with the correlation between the constructs. The square roots of the AVEs must be greater than the correlations of the constructs.	Fornell and Larcker (1981)
	HTMT	> 0.90	Henseler, Ringle and Sarstedt (2015); Hair, Howard and Nitzl (2020)

Next, it was estimated the structural model. In the structural model, the independent (exogenous) and dependent (endogenous) variables are related in order to measure and test the hypotheses.

The path coefficients (β value) were also analyzed (Hair, Howard & Nitzl 2020). In general, these values range from -1 to 1. This analysis is fundamental for evaluating the relationships created through the nine hypotheses of this study. Values closer to 0 (zero) indicate a weak relationship between exogenous and endogenous constructs, while the closer values are to 1, the stronger they are in predicting dependent constructs (Hair, Howard & Nitzl 2020).

Quality criteria were measured using R^2, Q^2 and variance inflation factor (VIF). The determination coefficient (R^2) of constructs was examined. R^2 values may vary from 0 (zero) to 1 (one). When values are closer to one, it indicates a greater predictive power that an endogenous construct has on an exogenous construct. In social and behavioral sciences, when R^2 values are equal to or above 2%, they have little effect on the endogenous variable; when R^2 values are above 13%, they have medium effect on the endogenous variable; when R^2 values are above 26%, they have big effect on the endogenous variable (Cohen, 1988). It is also

relevant to mention the effect size (f^2) (Cohen, 1988). It measures how much each construct is "useful" for the adjustment of the model (Hair et al., 2019).

The Q^2 analysis refers to the predictive validity or the Stone-Geisser indicator. It explains how close the theoretical model explanation is to what it was first expected of (Hair, Howard & Nitzl 2020). If values are higher than zero, it means that the model is suitable and significant (Hair et al., 2014; Ringle, Silva & Bido, 2014). This way, the model has predictive relevance. However, if Q^2 is lower than zero, it suggests poor predictive relevance. The variance inflation factor (VIF) is used to measure multicollinearity between constructs, and values below three are accepted (Hair et al., 2019). The next table shows the methods applied to the structural model.

Table 7. Methods applied to the structural model

Analysis	Methods	Values of reference	Sources
Path coefficient analysis	Verify the Beta (β) value	|1| = strong; 0 = weak	Hair et al. (2019)
Quality criteria	R^2 (Determination coefficient)	≥ 0.02 = small > 0.13 = medium > 0.26 = high	Cohen (1988)
	f^2 (Effect size)	> 0.02 < 0.15 = low ≥ 0.15 < 0.35 = medium ≥ 0.35 = high	Cohen (1988)
	Q^2 (Predictive relevance)	$Q^2 > 0$	Hair et al. (2014)
	VIF (Multicollinearity measurement)	< 3.0	Hair et al. (2014)

Finally, it was also performed additional analyses to check indirect effects. Four serial mediations were performed to check if trust and innovation performance are mediated by (i) network collaboration, (ii) interdependence, (iii) value co-creation and (iv) innovation orientation. This analysis was performed based on the recommendations of the Preacher and Hayes (2008). Partial mediation happens when the influence of the independent variable on the dependent variable is reduced after the mediator is controlled. On the other hand, complete mediation is present when the independent variable no longer influences the dependent variable after the mediator has been controlled (Baron & Kenny, 1986).

3.3.5 Conclusions

In this final chapter, it was highlighted the main results obtained, as well as limitations of the research and suggestions for future studies.

4. Analysis and discussion of results

This section discusses and analyzes the results of the research. Item 4.1 presents sample characteristics in relation to the actor's area of activity, time of existence, time of operation in the ecosystem and number of employees. Item 4.2 shows descriptive statistics of Likert scale items. Item 4.3 contains the test of the hypotheses and the analysis of the proposed research model. Lastly, item 4.4 provides the results obtained from the additional analyses, such as mediation.

4.1 Sample characteristics

In total, 121 valid answers from innovation ecosystem actors were obtained from the questionnaire application. The first part of the questionnaire is composed of questions that seek to identify the main characteristics of the sample. Most actors of these innovation ecosystems are part of the information technology sector (n=25), representing 20.66% of all respondents. Other sectors that appeared to be relevant in these ecosystems were health (n=20), representing 16.52%, research and education (n=13), representing 10.74%, industry (n=7), representing 5.78% and services (n=7), representing 5.78%.

Although innovation ecosystems are characterized by encompassing multiple actors from different backgrounds and sectors (Autio & Thomas, 2014; Su et al., 2018), there are some sectors that prevail depending on their circumstances. Considering the context of technological parks as the investigated innovation ecosystems of this study, three sectors represent together the amount of 47.93% of the sample, *i.e.*, information technology; health; and research and education.

Since we are analyzing actors from technology parks, it is coherent and also expected that the majority of organizations are technology-based. Primarily through incubators and spin-offs, these environments stimulate the creation and development of technology-based companies (Pompermaier & Prikladnicki, 2020). It is also known that relevant ecosystems were launched by ascendant tech companies that have used hyperscale platforms to be competitive in their market (Chung et al., 2020). The transformation of knowledge into new technologies in ecosystems is a source of competitive advantage (Robertson, Caruana & Ferreira, 2021).

The relevant participation of actors from the healthcare sector shown in this study might be due to the representativeness that the innovation ecosystem has in relation to healthcare

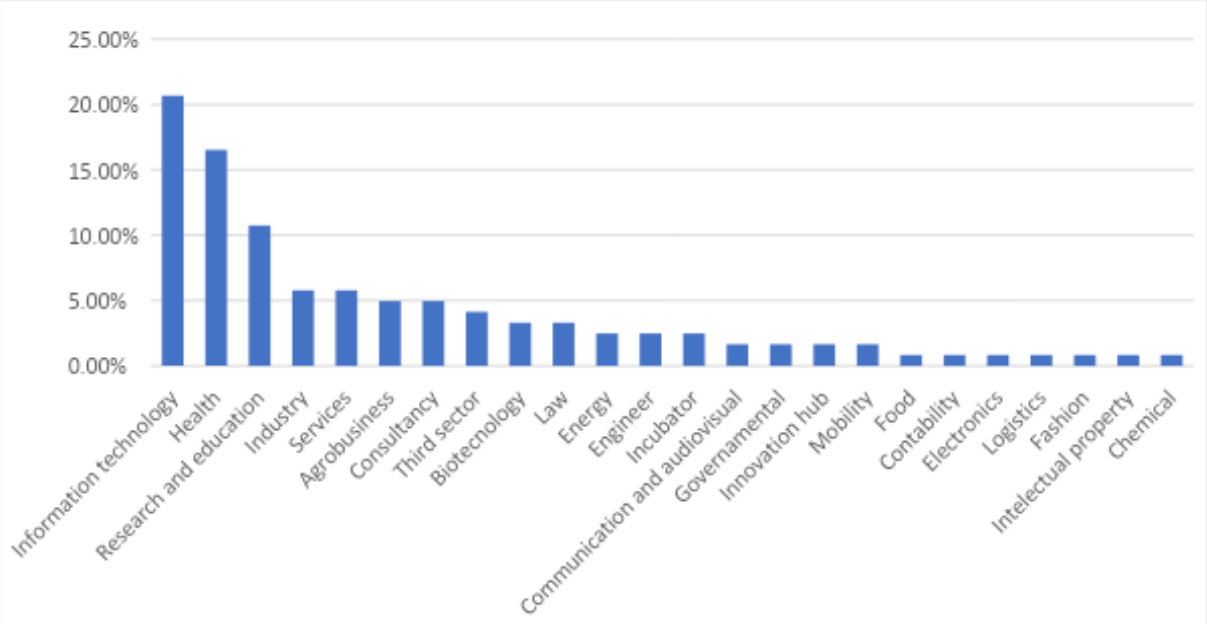
challenges. Innovation ecosystems, characterized by the interrelation among actors, could be an effective framework of reference for the healthcare industry (Granstrand & Holgersson, 2020). This environment allows collaborative mechanisms that are expected to enhance healthcare quality. Through its exchange of knowledge and resources, healthcare organizations expect to minimize costs and provide innovative solutions to the market (Lepore et al., 2023). Furthermore, innovation ecosystems have been considered in healthcare especially because there were already positive effects on the organizations' performance (Vlaisavljevic, Medina & Van Looy, 2020).

Research and education was the third most relevant sector present in the innovation ecosystems analyzed in this study. The four of them are science and technology parks from universities, thus, it becomes expected that institutions of research and education represent an expressive percentage of the sample. Universities play a considerable role in innovation ecosystems, since they not only develop human capital and advanced technology, but also participate as an economic development partner (Heaton, Siegel & Teece, 2019). This happens especially in universities of emerging economies that face multiple social challenges, so the education institution must go beyond teaching, researching and innovating along with industry (Thomas, Faccin & Ashein, 2021). Universities are increasingly promoting research, dissemination of knowledge and technology transfer, therefore, resulting in academic entrepreneurship and new technologies and solutions to the market.

It is also relevant to mention that governmental organizations were not expressively present in the ecosystems of this research, being represented by 1.65% (n=2) of the sample. This is in line with the previous suggestion of Sant'Ana et al. (2019) that the public sector is still a field to be explored in an ecosystem context. This is pertinent to be studied because local government institutions can play a considerable role in driving university-industry connections and enriching the innovation ecosystem (Sun et al., 2019). However, it may sometimes be challenging for government organizations to promote (or even facilitate) these connections.

Given this backdrop, figure 3 presents a summary of the previously mentioned, regarding sectors of the innovation ecosystem actors.

Figure 3. Sectors of the innovation ecosystem actors



Source: the author.

The next analysis is based on general frequencies of innovation ecosystem actors, that are presented in Table 8. Regarding the time of existence of the actors, the sample shows that they are mainly organizations that were founded between 1 to 5 years ago (n=47, 38.84%), followed by organizations that were founded between 5 to 10 years ago (n=28) and the ones that were founded more than 20 years ago (n=28), each representing 23.14%. No organization in this sample was founded less than 1 year ago.

Regarding the actors' time of presence in the innovation ecosystem, we have a difference in percentage of the scenario: 52.89% of the organizations of this sample have been present in the technology park between 1 and 5 years (n=64). Next, 19.83% of the actors have been present in the technology park between 5 and 10 years (n=24). Not surprisingly, only 3.3% (n=4) of the actors have been present in the innovation ecosystem for more than 20 years.

Regarding the number of people working on each innovation ecosystem actor, it is shown that organizations in technology parks usually have a small team, prevailing in 56.19% of the actors formed by less than 10 employees (n=68). Next, it comes the group of actors that have between 10 and 30 employees (n=28), representing 23.14%. Organizations with a large number of employees were not very common to be found in the innovation ecosystems analyzed for this research. Only 6 actors of the sample (4.95%) have between 101 and 500 employees, and these numbers are the same for actors who have more than 500 employees.

Table 8. General features of innovation ecosystem actors

Years of the organization's existence	< 1 year	1 to 5 years	5 to 10 years	10 to 15 years	15 to 20 years	> 20 years
Absolute frequency	0	47	28	13	5	28
Relative frequency	0	38.84	23.14	10.74	4.13	23.14
Years of the organization's presence at the technology park	< 1 year	1 to 5 years	5 to 10 years	10 to 15 years	15 to 20 years	> 20 years
Absolute frequency	10	64	24	11	8	4
Relative frequency	8.26	52.89	19.83	9.09	6.61	3.31
Number of workers in the organization	< 10	10 to 30	31 to 50	51 to 100	101 to 500	> 501
Absolute frequency	68	28	5	8	6	6
Relative frequency	56.20	23.14	4.13	6.61	4.96	4.96

Source: the author.

Overall, it can be seen that small organizations, with a small number of workers are the biggest beneficiaries from being part of an innovation ecosystem. Additionally, new organizations are also the majority of beneficiaries in innovation ecosystems, such as startups with not many years of existence. Startups have become an especially important channel for university-industry connections (Di Gregorio & Shane, 2003). This happens because actors like these can benefit more from the ecosystem structure, technology, and partnerships, as they do not yet have their own. Besides that, innovation ecosystems are a relatively recent structure, so, the data presented reflects that, in fact, the actors cannot be present in the ecosystem for so long, even those who have been there since its formation.

Identifying and analyzing the characteristics of the sample allows the understanding of the innovation ecosystem actors' profiles. This initial and descriptive analysis is necessary to contribute to the analysis of the role of trust among actors in innovation ecosystems. Given this

understanding, the next section brings descriptive statistics and frequencies of all Likert scale statements.

4.2 Sample responses on trust, network collaboration, interdependence, value co-creation, innovation orientation and innovation performance

The second part of the questionnaire presents statements that form the main constructs of the research: trust, network collaboration, interdependence, value co-creation, innovation orientation and innovation performance. In this section, all 31 statements (based on the applied questionnaire) are analyzed.

The trust construct was based on the 11 items of McKnight et al. (2002), subdivided in three dimensions that compose the concept of trust: ability (1 to 4), benevolence (5 to 7) and integrity (8 to 11). Cronbach's alpha is 0.948. The next analysis is based on the measures of central tendency in order to understand responses' variability information. The mean, median, standard deviation (SD), and mode are the most popular measures of central tendency. The mean refers to the average of a set of numbers. The median divides the sample into two parts, 50% on each side. The SD measures the sample's variability around the mean. The smaller the SD, the more homogeneous the responses. The larger the SD, the less homogeneous the responses. A SD of 0 would mean that all scores are the same. Finally, the mode is the value that was marked most frequently by the respondents (Field, 2009). The measures were based on a Likert scale in which 1 means "totally disagree"; 2 means "disagree"; 3 means "neither agree nor disagree"; 4 means "agree"; and 5 means "completely agree".

In Table 9, it is possible to observe these measures of each response for the trust items. Regarding ability (items 1 to 4), the mean of the responses remained close to 4, indicating that the majority of the respondents agree with the statements. This result shows that actors of innovation ecosystems believe their partners have the combination of necessary skills and competencies to influence other parties (Mayer et al., 1995). The same happens with the responses about benevolence (items 5 to 7). In line with Callens & Bouckaert (2019) and Colquitt et al. (2007), the majority of the respondents considers the actors of innovation ecosystems caring, openness and loyal, while having the willingness to cooperate with partners, facilitating each others' jobs. The four items concerning integrity (8 to 11) had a higher mean than the rest and a lower SD, which means a more homogeneity of the actors' responses. This shows that the actors assume that other actors in the same ecosystem follow similar principles

and rules (Mayer et al., 1995; McKnight et al., 2002). Overall, it is possible to infer that the actors of innovation ecosystems believe that their partners are trustworthy and would act in their best interest.

Table 9. Central tendency measures of trust items

Items	Mean	Median	SD	Mode
1. Actors of the innovation ecosystem are competent and effective in doing their business.	3.96	4	0.87	4
2. Actors of the innovation ecosystem perform their role in the ecosystem very well.	3.83	4	0.93	4
3. Overall, the actors of the innovation ecosystem are capable and proficient in doing their business.	3.97	4	0.84	4
4. In general, the actors of the innovation ecosystem are very knowledgeable about their business.	3.85	4	0.94	4
5. I believe that the actors of the innovation ecosystem would act in my best interest.	3.95	4	0.93	4
6. If I required help, the actors of the innovation ecosystem would do their best to help me.	4.07	4	0.87	4
7. The actors of the innovation ecosystem are interested in my well-being, not just their own.	3.85	4	0.95	4
8. The actors of the innovation ecosystem are truthful in their dealings with me.	4.12	4	0.80	4
9. I would characterize the actors of the innovation ecosystem as honest.	4.31	4	0.74	4
10. The actors of the innovation ecosystem keep its commitments.	4.03	4	0.76	4
11. The actors of the innovation ecosystem are sincere and genuine.	4.03	4	0.86	4

Source: the author.

The next table shows the measures of central tendency of responses for network collaboration statements. This scale was adapted from Sorenson et al. (2008). The mean of the responses in this section ranged from 3.71 to 3.77, while the SD ranged from 0.91 to 0.93 and the mode is 4. This reflects that even though the mean was lower than the previous analyzed answers, the majority of respondents still agree that network collaboration occurs in innovation ecosystem environments. This is in accordance with the concepts of the main literature of innovation ecosystem, in which goods and services are developed through network

collaboration (Adner, 2006; Granstrand & Holgersson, 2020; Iansiti & Levien, 2004; Scaringella & Radziwon, 2018).

Table 10. Central tendency measures of network collaboration items

Items	Mean	Median	SD	Mode
12. We exchange accurate information to solve the problem together.	3.77	4	0.92	4
13. We try to bring all our concerns out in the open so that the issues can be resolved in the best possible way.	3.71	4	0.93	4
14. We try to work with one another for a proper understanding of the problem.	3.72	4	0.91	4

Source: the author.

The next Table presents central tendency findings for interdependence. Results show that statements 15 and 17 have the median of 4, following the pattern of previous analyzed questions. The biggest difference here is the mode of 3 ("neither agree nor disagree") shown in question 16. According to this statement, it seems that, in general, dependence of other actors to perform certain activity has a neutral perception of the respondents, not being so clear if this exists or not in ecosystems environments.

Table 11. Central tendency measures of interdependence items

Items	Mean	Median	SD	Mode
15. We cannot accomplish some of our company's activities without information or materials from other actors of the innovation ecosystem.	3.79	4	0.94	4
16. Other actors of the innovation ecosystem depend on our company for information or materials needed to perform their activities.	3.23	3	1.05	3
17. Within the innovation ecosystem, activities performed by actors are related to one another.	3.58	4	0.99	4

Source: the author.

The measures of central tendency of responses for value co-creation statements are shown in the next table (Table 12). It is possible to observe that the mean of the three questions range from 3.48 to 3.63 and the mode prevails in 4 ("agree"), meaning that value co-creation is one of the perceived features of innovation ecosystems from its actors. This result reinforces the concepts of Aarikka-Stenroos & Ritala (2017), Adner (2006) and Gomes et al. (2018), which emphasize the existence of value co-creation in innovation ecosystems.

Table 12. Central tendency measures of value co-creation items

Items	Mean	Median	SD	Mode
18. Overall, involving actors of the innovation ecosystem in our activities has been a success.	3.59	4	0.93	4
19. The contribution of various actors of the innovation ecosystem has been vital for developing our products/services.	3.48	4	1.15	4
20. Our products and services that have been developed considering other actors' participation and knowledge have been accepted by the market.	3.63	4	0.98	4

Source: the author.

The group of responses related to innovation orientation brings higher numbers, as shown in Table 13. The majority of the actors marked 5 ("completely agree"). This reveals that innovation orientation is a strong issue in organizations that are part of innovation ecosystems, which is in accordance with Ritala & Almpanopoulou (2017). Standard deviation was also lower in this block of the questionnaire compared to others, indicating a tendency to more homogeneous responses regarding this topic.

Table 13. Central tendency measures of innovation orientation items

Items	Mean	Median	SD	Mode
21. The organization I work for pays close attention to innovation.	4.66	5	0.60	5
22. The organization I work for emphasizes the need for innovation for development.	4.69	5	0.59	5
23. The organization I work for promotes the need for development and utilization of new resources.	4.54	5	0.66	5
24. The organization I work for embraces, accepts, and measures innovation.	4.11	4	0.91	4
25. The organization I work for actively seeks innovative ideas.	4.53	5	0.67	5
26. The organization I work for encourages people for new ideas even if they don't work.	4.46	5	0.67	5

Source: the author.

The following table indicates the measures of central tendency of responses for innovation performance statements. In general, the respondents agree or completely agree that the organization they work is focused on innovation performance - adopting the concept of product innovation (Brown & Eisenhardt, 1995, Zhang & Li, 2010; Zhang & Liu, 2022).

Considering that environments such as innovation ecosystems imply that the actors prosper together, it is beneficial that their partners focus and seek innovation performance, so it can be beneficial to the whole network of actors.

Table 14. Central tendency measures of innovation performance items

Items	Mean	Median	SD	Mode
27. The organization I work for frequently introduces new products.	4.32	4	0.73	5
28. The organization I work for is often the first in new product introductions in the market.	3.68	4	0.99	4
29. The organization I work for quickly launches new products into the market.	3.51	4	1.03	4
30. The organization I work for develops new products with superior quality.	4.07	4	0.83	4
31. The organization I work for uses new products to penetrate markets.	4.01	4	0.94	4

Source: the author.

This section contains relevant information about data collected. It was revealed that the constructs of the questionnaire have internal reliability values, since Cronbach's alpha is greater than 0.6. (α=0.948). This indicates that the scales used and adapted to define the constructs in the questionnaire were adequate. Although it was presented an overview analysis of the descriptive statistics of each construct, they were analyzed separately. In order to analyze them together and to test the proposed model and hypotheses, the following section comprehends the results of the partial least squares structural equation modeling (PLS-SEM).

4.3 Partial least square structural equation model analysis - direct effects

Partial least squares structural equation modeling (PLS-SEM) was used to test and analyze the hypotheses of this research. This method allows researchers to simultaneously model and estimate complex relationships of dependent and independent variables (Hair et al., 2022). PLS-SEM enables a more precise measurement of the theoretical concepts involved in the proposed model (Cole & Preacher, 2014). Based on the evaluation of the proposed model, it was not necessary to make adjustments because all the results were in accordance with the minimum necessary suggested by the literature, as shown in the method section.

Table 15 presents the factor loadings, reliability and convergent validity of the variables of the measurement model, and the results are shown to be adequate. In relation to loadings, Hair et al. (2017) suggest values higher than 0.7 (and higher than 0.6 in exploratory research). There is only one result that came out lower than 0.7 (for interdependence), but higher than 0.6. For internal consistency reliability (Cronbach's Alpha, rho_a; Composite Reliability), it is suggested that the indicator remain above 0.7 (Hair et al., 2017), as it is shown in the table below. And finally, the Average Variance Extracted (AVE) must not be lower than 0.5 to demonstrate an acceptable level of convergent validity (Hair et al., 2019) and all the results match this requirement.

Table 15. Factor loadings, reliability and convergent validity (second order variables)

Constructs	**Loadings**	**Cronbach's alpha**	**rho_A**	**Composite reliability**	**AVE**
Trust	[0.896; 0.922]	0.948	0.950	0.935	0.828
[1]Ability	[0.847; 0.938]	0.924	0.926	0.946	0.815
[1] Benevolence	[0.815; 0.922]	0.835	0.841	0.901	0.753
[1] Integrity	[0.873; 0.936]	0.921	0.925	0.944	0.809
Network collaboration	[0.865; 0.915]	0.880	0.882	0.926	0.806
Interdependence	[0.680; 0.874]	0.759	0.834	0.853	0.662
Value co-creation	[0.788; 0.891]	0.809	0.849	0.884	0.719
Innovation Orientation	[0.751; 0.895]	0.913	0.917	0.932	0.698
Innovation Performance	[0.737; 0.833]	0.851	0.854	0.894	0.627

[1]First order variables
Source: the author.

It is important to mention that trust is a second-order variable composed of three first-order variables: ability (A), benevolence (B), and integrity (I). The calculation method applied in this case was the indicator repetition approach, with type I structure, i.e., reflective-reflective (Sarstedt et al., 2020). Also because of that, the composite reliability and AVE indicators were measured with Microsoft Excel spreadsheet version 16.

Next, in Table 16, it is shown the results of discriminant validity. The Fornell-Larcker and the heterotrait-monotrait ratio of correlations (HTMT) values are presented.

Table 16. Discriminant validity - Fornell-Larcker and HTMT criterions

Fornell-Larcker						
	TR	**NC**	**IN**	**VC**	**IO**	**IP**
TR	**0.910**					
NC	0.576	**0.898**				
IN	0.266	0.358	**0.814**			
VC	0.532	0.661	0.551	**0.848**		
IO	0.297	0.351	0.162	0.296	**0.835**	
IP	0.249	0.477	0.358	0.420	0.697	**0.792**
HTMT						
	TR	**NC**	**IN**	**VC**	**IO**	**IP**
TR						
NC	0.623					
IN	0.281	0.415				
VC	0.563	0.757	0.680			
IO	0.312	0.384	0.207	0.334		
IP	0.285	0.549	0.426	0.512	0.778	

Note 1: TR = trust; NC = network collaboration; IN = interdependence; VC = value co-creation; IO = innovation orientation; IP = actors' innovation performance.
Note 2: Values in bold on the upper diagonal represent the square root of AVE.
Source: the author.

Table 17 presents the results of discriminant validity, according to Fornell-Larcker and HTMT criterions for the first order variables of trust (ability, benevolence and integrity).

Table 17. Discriminant validity - Fornell-Larcker and HTMT criterions (first-order variables)

Fornell-Larcker			
	AB	**BN**	**ITG**
AB	**0.903**		

BN	0.750	**0.868**	
ITG	0.732	0.752	**0.900**
HTMT			
	AB	**BN**	**ITG**
AB			
BN	0.850		
ITG	0.790	0.853	

Note: AB = ability; BN = benevolence; ITG = integrity.
Note 2: Values in bold on the upper diagonal represent the square root of AVE.
Source: the author.

According to the results shown in tables 14 and 15, the values are also appropriate. The results are in accordance with the Fornell-Larcker criterion, since all the square roots of the AVEs were greater than the correlations of the constructs. Regarding HTMT, the values presented are lower than 0.9, as suggested by Hair et al. (2019). Thus, there were no problems with discriminant validity and the presented results allow the continuation of the statistical analysis.

Table 18 presents the results obtained in relation to the hypotheses of this research. Results indicate that H7 ($\beta = 0.057$; $p = 0.535$) and H9 ($\beta = -0.154$; $p = 0.120$) were not supported, while the other hypotheses (H1, H2, H3, H4, H5, H6 and H8) were all supported, since they had $p < 0.05$. Therefore, the findings indicate that seven path coefficients are significant and in the expected (positive) direction, meaning that the statistical analysis confirmed the relationships proposed in the model regarding H1, H2, H3, H4, H5, H6 and H8. Besides that, H1, H2, H3, H4, H5 and H8 had $p < 0.01$, which means that there is 1% of significance and 99% of reliability for these hypotheses. Regarding f^2 results, the highest effect size was shown by the influence of innovation orientation on innovation performance (n=0.783), while the lowest effect size was represented by the influence of value co-creation on innovation performance (n=0.003).

Table 18. Test of hypotheses

Hypotheses	Relation	β	t-value	f^2	p	Conclusion
H1	TR → NC	0.576	7.211	0.495	0.000***	Supported

H2	TR → IN	0.266	2.722	0.076	0.007***	Supported
H3	TR → VC	0.532	7.886	0.394	0.000***	Supported
H4	TR → IO	0.297	2.947	0.097	0.003***	Supported
H5	NC → IP	0.251	2.651	0.074	0.008***	Supported
H6	IN → IP	0.179	2.424	0.055	0.015**	Supported
H7	VC → IP	0.057	0.620	0.003	0.535	Not Supported
H8	IO → IP	0.609	10.182	0.783	0.000***	Supported
H9	TR → IP	-0.154	1.557	0.036	0.120	Not Supported

Note 1: H = hypothesis; TR = trust; NC = network collaboration; IN = interdependence; VC = value co-creation; IO = innovation orientation; IP = actors' innovation performance.
Note 2: * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.
Source: the author.

The results presented in the next table (Table 19) consist of quality criteria analyses. The findings reflect an adequate level of variance (R^2) explained by the endogenous variables. It resulted in small predictive power for interdependence and innovation orientation, since $R^2 \geq 0.02$; and high predictive power for network collaboration, value co-creation, and innovation performance, whereas $R^2 > 0.26$. Results mean that trust explains 33.1% ($R^2 = 0.331$) of the variance in network collaboration, 7.1% ($R^2 = 0.071$) of the variance in interdependence, 28.3% ($R^2 = 0.283$) of the variance in value co-creation and 8.8% ($R^2 = 0.088$) of the variance in innovation orientation. It also indicates that together, trust, network collaboration, interdependence, value co-creation and innovation orientation explain 59.3% ($R^2 = 0.593$) of the variance in the actors' innovation performance.

Following Hair et al. (2019), Q^2 is greater than zero for all constructs of this research, indicating the proposed model is suitable and significant. Additionally, VIF indicates a possible multicollinearity and the results are appropriate, since all of them are lower than three (Hair et al., 2019). Hence, there was no need to exclude any latent variables.

Table 19. Quality Criteria

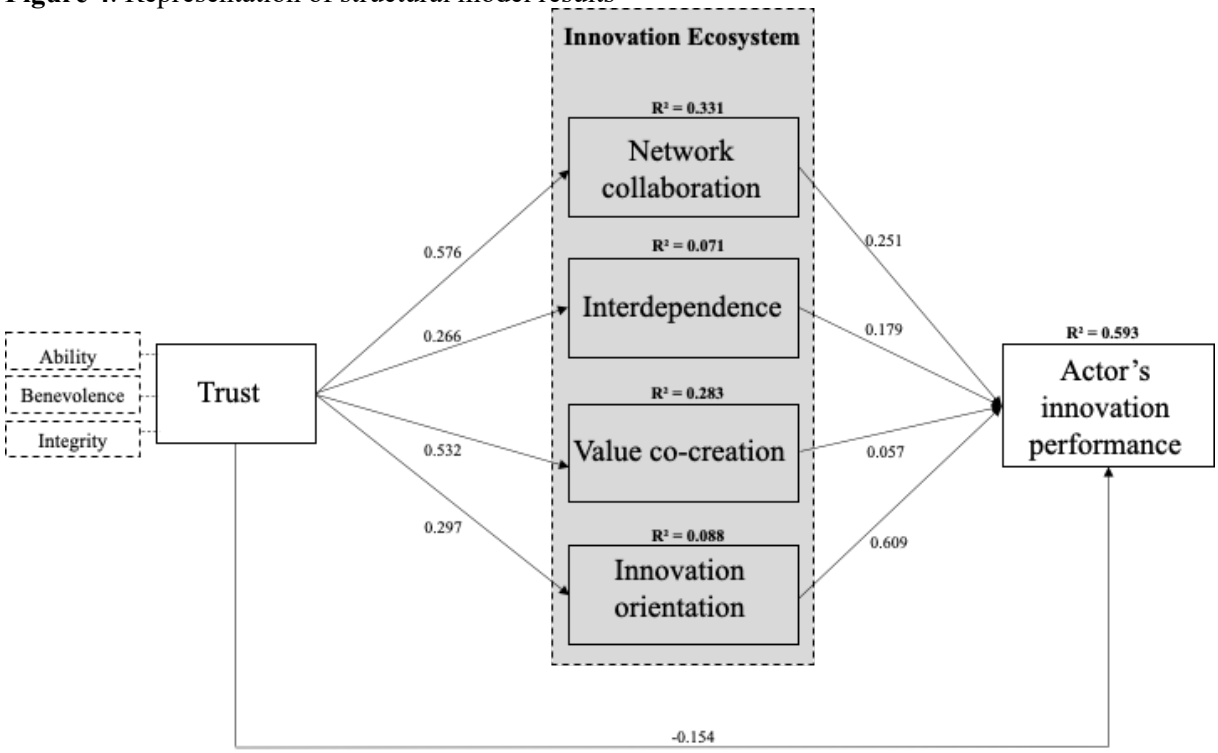
Endogenous variable	**R^2**	**R^2 adj**	**Q^2**	**maximum VIF**
NC	0.331	0.326	0.253	1.000
IN	0.071	0.063	0.019	1.000
VC	0.283	0.277	0.163	1.000

IO	0.088	0.081	0.055	1.000
IP	0.593	0.576	0.351	2.364

Note: NC = network collaboration; IN = interdependence; VC = value co-creation; IO = innovation orientation; IP = actors' innovation performance.
Source: the author.

Summarizing what was explored so far, Figure 4 presents the proposed model of this study with the results of standard β and R^2 of the analyzed constructs.

Figure 4. Representation of structural model results



Source: the author.

After verifying which hypotheses are supported and which are not, the following sections are dedicated to the discussions of these results.

4.3.1 Discussing the influence of trust on the innovation ecosystem's dimensions

The relevance of trust may be one of the central topics when involving multiple actors from the same network collaboration (Cobben et al., 2023). Trust is a key element for the functioning of networks, since joint collaboration is part of their value (Giest, 2019). The

findings of this research show that H1 was supported ($\beta = 0.576$; $p < 0.01$), evidencing that trust positively influences network collaboration.

It was already indicated in the literature that there is a positive and pertinent relation between trust and network collaboration. The results of this research corroborate with Shazi et al. (2015), since they state that some of the actors' intentions when participating in network collaborations is to exchange knowledge from honest and reliable sources. This might be possible because trust stimulates the free flow of knowledge among network players. The study also confirmed what was already suggested by Lane et al. (2001) and Wang and Chen (2012). The authors affirmed that when trusting partners and sharing resources becomes routine and natural, it makes actors want to help each other, corroborating for network prosperity.

Based on the results shown through H1, it was proved that the findings are in line with Wang and Chen (2012), which describe trust as an encouraging element for network collaboration relationships. Furthermore, when network collaboration is based on trust, it reduces the propensity for opportunistic behavior among partners (Dogbe et al., 2020; Mazzola et al., 2015).

Bearing in mind that sharing information in an effective and efficient way is essential to achieve success (Massaro et al., 2019), it can be said that trust helps to create network collaborative dynamics in competitive settings, facilitating the emergence of innovation (Giest, 2019). Network collaboration partners build trust by sharing information and knowledge, demonstrating competency, good intentions and partnership over longer periods of time (Klijn et al., 2015). Therefore, just as in theory, empirical research confirmed the existence of a positive and significant relation between trust and network collaboration.

The results of our study also indicate that trust positively influences interdependence ($\beta = 0.266$; $p < 0.01$), supporting the H2 of the proposed model. It was evidenced that environments of risks and uncertainties such as innovation ecosystems require complementarity of resources, skills and knowledge, indicating that players need each other towards achieving individual and collective objectives.

Our findings are in line with Mayer et al. (1995), since they affirm that the ability of one organization influences its partners and creates interdependence. It was also found that concomitant trust among players increases the level of joint involvement and interdependence, increasing social solidarity and cooperation in business relationship (Provan, 1994). Results are in accordance with Massaro et al. (2019), who believe that interdependent players seek partners with similar ethical and moral values.

Reinforcing this argument, the literature has already identified that interdependent relations based on trust nurture coopetition, which includes, simultaneously, cooperation and competition (Chai et al., 2019, Zen et al., 2023), and this is one of the characteristics of innovation ecosystems' context. In innovation ecosystems environments, these relationship attributes are fundamental to set a healthy dynamic, because it cultivates exchanges among actors.

Our findings indicate that sustaining trust among actors of innovation ecosystems is crucial to interdependence relations, because this allows organizations to preserve high commitment and continuous joint actions. Therefore, it encourages actors to explore new techniques to coordinate activities in order to improve the emergence of innovation. This is particularly relevant for actors classified as startups or newly founded companies operating in innovation ecosystems, because most of them do not have all the necessary resources and skills to properly function, so they have stronger dependent relationships with other actors, as a way of accomplishing certain activities.

In relation to the dimension of value co-creation, the results of this research indicate that H3 was supported ($\beta = 0.532$; $p < 0.01$), therefore, it was found that trust also positively influences value co-creation. Our findings are in the same direction as the studies of Lei et al. (2020) and Shulga et al. (2021), which already evidenced in the literature the relevance of trust on value co-creation. They also mention that trust has a special role as a precondition to value co-creation.

Trust plays an important role in motivating innovation ecosystem actors to co-create. If there is a strong relation of trust among them, loyalty, collaboration and engagement with partners are positively influenced (Ferm & Thaichon, 2021), and so is the willingness to co-create value. With the results of this research, we have noticed that trust might be a necessary condition for value co-creation, otherwise, actors prefer not to jointly collaborate.

Innovation ecosystem, due to its nature of operation, creates shared value (Piantoni, et al., 2023). Morgan and Hunt (1994) add that continuous value sharing and collaboration are imperative to build trust. To continue with this co-creation of value and doing it in a more beneficial way for all the actors involved, it is required to trust partners. This corroborates with Shulga et al. (2020), indicating that trust is not only desirable but a necessary condition to perform a successful value co-creation. Therefore, it can be said that the research results are consistent with the literature.

Overall, it was observed that the relation between trust and value co-creation in innovation ecosystems stimulates a continuous flow. That is, whenever actors participate in co-creation activities because they trust each other, they all acquire various benefits, which elevate their trust in their partners. If done properly, it can become a positive and advantageous never-ending relationship.

In relation to H4, our findings suggest that trust positively influences innovation orientation, considering that the hypothesis was also supported ($\beta = 0.297$; $p < 0.01$). It is known that trust is vital to innovation (Han, 2018). This statement can be justified because trust is a fundamental element in influencing and encouraging knowledge sharing, which, by its turn, facilitates innovation (Abu El-Ella et al., 2016). That fact was also proved in this research, in which it was evidenced the need for trust towards creating innovation outcomes among innovation ecosystem actors. This suggests that trust can foster innovation orientation by allowing organizations to share information and skills in innovation ecosystem environments without having fears and knowing that the same way as they are sharing their knowledge, they are also being benefited from others.

As previously indicated by Lii & Kuo (2016), organizations that are innovation-oriented appreciate long term relationships. According to our research, a possible way of achieving that in an innovation ecosystem context is having trustworthy relationships, because such environments, as stated by Paasi et al. (2023), are considered systems that do not produce standalone innovations. Therefore, if actors build long-term relationships based on trust, innovations will come out easily and fulfill customer needs into a systemic solution.

The next Table shows the results of the empirical test of these four hypotheses and the corresponding literature that they are aligned with.

Table 20. Hypothesis alignment with literature (H1 to H4)

Hypothesis	Result	Supporting literature
H1	*Trust positively influences network collaboration*	Dogbe et al., 2020; Giest, 2019; Mazzola et al., 2015; Shazi et al., 2015; Wang and Chen, 2012.
H2	*Trust positively influences interdependence*	Chai et al., 2019; Massaro et al., 2019; Mayer et al., 1995; Zen et al., 2023.
H3	*Trust positively influences value co-creation*	Lei et al., 2020; Shulga et al., 2021.
H4	*Trust positively influences innovation orientation*	Lii & Kuo, 2016; Paasi et al., 2023.

Given that H1, H2, H3 and H4 are supported, this study sheds light on at least two aspects. First, it was proved that trust has a positive effect on the four dimensions of innovation

ecosystems (network collaboration, interdependence, value co-creation and innovation orientation). This might suggest that trust among actors is considered a prerequisite to establish relationships in innovation ecosystems. It was evident that without trust, players will not have enough motivation to collaborate in networks, to depend on other actors, to co-create with other actors and to seek mutual innovation outcomes. A possible reason is that, from the basis, every interorganizational relation that is characterized by a considerable amount of involvement has to be based on trust (Bstieler et al., 2017; Donati et al., 2019;). And if considered a challenging, unknown and innovative environment such as innovation ecosystems, this requirement is even more significant.

Second, these results provide valuable insights that the influence of trust on innovation ecosystems (through the four dimensions) can even increase the quality and the scope of the exchanged knowledge and skills. In other words, if actors strongly trust their partners, it is assumed that they will exchange information with great accuracy, details and in a timely manner. We presuppose this occurs because trustworthy relations allow actors to feel confident that they will be reciprocated. Such finding reinforces the relevance of studying the relationships and the dynamics of innovation ecosystems, which, according to Paasi et al. (2023), still require further studies.

4.3.2 Discussing the influence of the innovation ecosystem's dimensions on the actors' innovation performance

Regarding the first dimension of innovation ecosystems, results show that network collaboration positively influences the actors' innovation performance. Since H5 was supported ($\beta = 0.251$; $p < 0.01$), this corroborates with the studies of Cobben et al. (2023) and Dogbe et al. (2020). For the authors, the complementary nature of innovation ecosystems and the network embeddedness allow better organization-level indicators which positively impacts collaborative innovation performance. The study is also in line with Gnyawali and Srivastava (2013) and Luo (2022), who argue that an organization can achieve superior innovation performance by collaborating and combining expertise in networks.

Dogbe et al. (2020) highlight that network collaboration is especially effective and beneficial for small and medium sized enterprises. This can be at some point related to startups that are part of the analyzed technological parks. Data show that this type of organization was frequently found in the innovation ecosystems analyzed for this research. Since they are new

and still small in comparison to other organizations of the ecosystem, they are in advantage because they can absorb new knowledge from more experienced actors, which might help them to develop new products.

Network collaboration among partners allows the absorption of external knowledge sources, taken that the main characteristic of networks is that organizations interact and exchange information with each other. Actors sustain relationships with other actors to acquire resources, to allow knowledge creation and innovation. Consequently, having multiple knowledge from different sources contributes to incrementing the organizations' innovation performance (Mokhtarzadeh et al., 2020; Wang & Chen, 2012). Taking into account that this knowledge exchange is facilitated by network collaboration, the latter can be considered a key contributor to innovation performance (Mazzola et al., 2015).

Having this said, we suppose that the positive influence of network collaboration on the actors' innovation performance may be due to facilitating mutual support and the sharing of innovation ideas among network organizations. These findings allow actors to deliberate how they intend to position themselves in the ecosystem. This standpoint can help actors to focus on participating in network collaborations that might give them greater benefits, transforming external innovative inputs into higher innovation performance.

An essential premise for an innovation ecosystem to exist is the inherent interdependencies between different actors and tasks. Successful outcomes of an innovation ecosystem frequently depend on the compatibility and complementarity between items produced by interdependent actors in the ecosystem (Adner & Kapoor, 2010; Jacobides et al., 2018). With respect to the association of interdependence and the actors' innovation performance, findings revealed that H6 was supported ($\beta = 0.179$; $p < 0.05$), evidencing that interdependence positively influences the actors' innovation performance. This positive relationship was also observed by Wu et al. (2023). For the authors, interdependence between organizations encompasses joint actions, mutual trust, knowledge sharing and high commitment. These actions contribute to the acquiring of capabilities which allow the creation and transformation of new technologies for innovation, which will lead to higher innovation performance.

According to social interdependence theory (Johnson & Johnson, 2009), interdependence is established as the extent to which one party influences others. With the data obtained in the research, it can be seen that once this relationship is settled, it also contributes to perpetuating joint actions and high commitment, motivating actors to interact more

frequently in search of achieving innovation performance. Therefore, the positive relation occurs by means of mediating ideas generation and implementation, that will result in higher innovation performance.

The positive relation among these two constructs may be because high levels of interdependence presuppose that there is a high degree of interaction among innovation ecosystem actors, who can contribute to each other by exchanging the necessary knowledge and resources for idea implementations. Overall, we found that interdependence strengthens the positive relationship among innovation ecosystem actors, which according to Zhang & Li (2021), results in higher levels of innovation performance. This conclusion is consistent with the inference made on H6 in the theoretical background of this study.

In relation to the seventh hypothesis proposed in this research, H7 was not supported ($\beta = 0.057$; $p=0.535$). Different from what was found by Stock et al. (2017), Westerlund and Rajala (2010) and Baraldi et al. (2012), results showed that value co-creation by itself did not appear to be relevant in influencing the actors' innovation performance. The literature is still contradictory about the effect of value co-creation on innovation performance (Markovic & Bagherzadeh, 2018). A group of researchers have found that co-creating with multiple players positively influences innovation performance (Baraldi, Gressetvold & Harrison, 2012; Dahlin et al., 2020; Otchere et al., 2019; Stock, Zacharias & Schnellbaecher, 2017; Tsou, Chen & Yu, 2019; Westerlund & Rajala, 2010), as suggested by this research in H7. However, another group has shown a negative effect (*e.g.*, Knudsen, 2007; Knudsen & Mortensen, 2011). These confusing findings do not make clear how organizations can take advantage from value co-creation with other players and bring light to other interpretations of these conflicting results.

Similarly to our study, Markovic and Bagherzadeh (2018) also found that stakeholders co-creation is not directly associated with innovation performance. The authors argue that this relationship does exist, but it is completely mediated by product innovation, or through knowledge sharing and then product innovation. A feasible interpretation of our results for H7 can be close to what these authors pointed out. It may be that, in innovation ecosystems environments, value co-creation does not have a direct effect on the actors' innovation performance, but there might be other variables related to the co-creation process that mediate the relation between these two constructs. We assume that perhaps there are items that help actors to improve their product quality (*e.g.,* knowledge sharing, resource sharing, trust relations, strong communication), which in turn are likely to boost innovation performance.

Therefore, it makes sense that value co-creation among actors in innovation ecosystems is not directly related to the actors' innovation performance, but instead this relationship is completely mediated by other elements. This analysis can even clarify some of the conflicting literature of how value co-creation can influence innovation performance.

Our findings also identified that H8 was supported ($\beta = 0.609$; $p < 0.01$), suggesting that innovation orientation positively influences innovation performance. Therefore, actors focused on innovation orientation are more likely to have a higher innovation performance. The literature also points towards this direction (Ayoub, Abdallah, & Suifan, 2017; Aalbers & Dolfsma, 2015; Lii & Kuo, 2016; Shehadeh et al., 2016; Whelan et al., 2011). Our study is in accordance with Zhang and Duan (2010), who assumed that innovation orientation allows organizations to be proactive in anticipating new ideas and opportunities as well as exceeding customer expectations and, therefore, raising levels of innovation performance.

Innovation orientation is also relevant in dealing with the openness to new ideas. Hurley and Hult (1998) have already emphasized that innovation orientation stimulates openness to new ideas, which enhances the organizations' innovation performance (Abdallah, Dahiyat, & Matsui, 2019). Innovation orientation leads to innovation outcomes, which will eventually affect the organizations' innovation performance (Siguaw et al., 2006). The same way as Siguaw et al., (2006), based on our results, we believe that the impact of innovation orientation on innovation performance is also due to the encouragement of competence acquisitions that facilitate innovation. Our findings strengthen the model proposed by Stock and Zacharias (2011), in which an integrated approach of innovation orientation induces higher levels of innovativeness.

In innovation ecosystems, the positive relation of these two constructs is probably because the ultimate goal of innovation orientation is to drive the organization towards enhancing the created value and bringing benefits to its external stakeholders, which is a strong characteristic of innovation ecosystems' dynamics. That being so, innovation ecosystem actors need to know that in order to create a proper and positive innovative environment, it is essential to include innovation orientation as a driver for their organization to achieve superior innovation performance. Thus, results show that innovation orientation is vital for enhancing innovation performance in innovation ecosystem contexts.

The next Table shows the results of the empirical test of these four hypotheses and the corresponding literature that they are aligned with.

Table 21. Hypothesis alignment with literature (H5 to H8)

Hypothesis	Result	Supporting literature
H5	*Network collaboration positively influences the actors' innovation performance*	Cobben et al., 2023; Dogbe et al., 2020; Gnyawali and Srivastava, 2013; Luo, 2022.
H6	*Interdependence positively influences the actors' innovation performance*	Zhang & Li, 2021; Wu et al., 2023.
H7	*Value co-creation does not positively influence the actors' innovation performance*	Knudsen, 2007; Knudsen & Mortensen, 2011; Markovic and Bagherzadeh; 2018.
H8	*Innovation orientation positively influences the actors' innovation performance*	Ayoub, Abdallah, & Suifan, 2017; Aalbers & Dolfsma, 2015; Lii & Kuo, 2016; Shehadeh et al., 2016; Whelan et al., 2011.

The results of this study reinforce the relevance of each innovation ecosystem dimension on the actors' innovation performance. We observe that only one of these relations did not prove to be positively significant (H7), while H5, H6 and H8 were supported. Innovation orientation, network collaboration and interdependence positively influence the actors' innovation performance. Regarding network collaboration, we believe it positively influences the actors' innovation performance because since many actors of the sample are new in the market and usually have little experience, they are more likely to value network collaboration and make use of the resources exchanged. Interdependence also proved to have an effect on the actors' innovation performance perhaps because after exchanges occur and actors gain trust on each other, they build mutual dependence relations in order to generate innovation, which will increase their innovation performance (Donati et al., 2019; Ritala et al., 2013). Lastly, a feasible explanation concerning innovation orientation is that innovation ecosystems, and especially configured as technological parks, are mainly composed of startups and new organizations, which are focused on innovation (Di Gregorio & Shane, 2003).

4.3.3 Discussing the influence of trust on the actors' innovation performance

The logic built on the theoretical background section to propose H9 was not sustained, since the results showed that H9 was not supported ($\beta = -0.154$; $p=0.120$). While some studies describe that trust influences the organizations' innovation performance (Abu El-Ella et al., 2016; Han & Chen, 2018; Selnes & Sallis, 2003; Wang et al., 2014), the findings of this research did not prove that this relation is significant in innovation ecosystems. A feasible explanation for this hypothesis not being sustained might be because trust influences other aspects that afterwards will influence innovation performance. For example, Han & Chen, 2018 affirm that

trust relationships have a positive effect on knowledge sharing, which will eventually have a positive effect on innovation performance.

The next Table shows the results of the empirical test of the nineth hypothesis and the corresponding literature that it is aligned with.

Table 22. Hypothesis alignment with literature (H9)

Hypothesis	Result	Supporting literature
H9	*Trust does not positively influence the actors' innovation performance*	Han & Chen, 2018;

This shows that in the direct relation, trust does not positively influence the actor's innovation performance. Thus, there is no direct and significant effect of trust on innovation performance. However, it is worth highlighting that the research proved that trust positively influences network collaboration (H1), interdependence (H2), value co-creation (H3) and innovation orientation (H4). Going further, the actors' innovation performance is positively influenced by network collaboration (H5), interdependence (H6) and innovation orientation (H8). The dimension of value co-creation is the only one that does not have a significant effect on innovation performance (H7). So, trust positively influences four innovation ecosystem dimensions and three of those dimensions positively influence the actors' innovation performance. Therefore, these findings reinforce the proposed model (Figure 1), in which dimensions of innovation ecosystems must be mediating and facilitating the relationship between trust and innovation performance. The next section will focus on exploring the mediating effects found in this study.

4.4 Partial least square structural equation model analysis - indirect effects

Considering that few studies (*e.g.*, Benitez et al., 2020; Cobben & Roijakkers, 2018; Pattinson et al., 2018; Teramoto & Jurčys, 2017) address trust in innovation ecosystems, this research proposes a model as an attempt to show that trust is relevant to the four proposed dimensions of innovation ecosystems (*i.e.*, network collaboration, interdependence, value co-creation and innovation orientation), which, in turn, are relevant to the actors' innovation performance, showing the complexity behind these relations.

Additional analyses were performed in order to test possible indirect effects. It was performed four serial mediations to verify if: (i) network collaboration mediates the relationship between trust and actors' innovation performance; (ii) interdependence mediates the

relationship between trust and actors' innovation performance; (iii) value co-creation mediates the relationship between trust and actors' innovation performance; and (iv) innovation orientation mediates the relationship between trust and actors' innovation performance. The results of such analyses are shown in Table 23.

Table 23. Additional tests - indirect effects

Relations	β	t-value	p	Conclusion
TR → NC → IP	0.144	2.347	0.019**	complete mediation
TR → IN → IP	0.048	1.674	0.094*	complete mediation
TR → VC → IP	0.030	0.597	0.550	not significant
TR → IO → IP	0.181	2.768	0.006***	complete mediation

Note 1: TR = trust; NC = network collaboration; IN = interdependence; VC = value co-creation; IO = innovation orientation; IP = actors' innovation performance.
Note 2: * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

Numbers shown in Table 19 reveal that this study presents three complete mediations, which are between trust and (i) network collaboration, (ii) interdependence and (iii) innovation orientation. The mediation did not happen with only one innovation ecosystem dimension: value co-creation.

Therefore, the findings suggest that the relationship between trust and the actors' innovation performance is mediated by network collaboration ($p < 0.05$), innovation orientation ($p < 0.05$), as well as by interdependence ($p < 0.10$). Considering that the direct relation between trust and innovation performance is not significant, there are three complete mediations in this research. It strengthens the formulation of the innovation ecosystem dimensions suggested in the theoretical background of this study. This means that there is a need for the dimensions of the innovation ecosystem to be there, because they mediate the relationship between trust and the actors' innovation performance.

These results are pertinent, since few studies (Wang, Su & Zhang, 2023; Zhang, Wang & Xu, 2021; Wei et al., 2021; Soral et al., 2023) have tested complex relationships, such as mediation, in the field of innovation ecosystem. Understanding the effect of mediations regarding the relationships of actors in innovation ecosystems allows a deep analysis of its dimensions that are fundamental to achieving higher innovation performance. Our findings serve as a warning for innovation ecosystem actors about the importance of focusing on three aspects of innovation ecosystems (*i.e.*, network collaboration, interdependence and innovation

orientation) in order to achieve higher innovation performance. This reinforces the need for collaborative environments based on trust relationships between actors.

Overall, the thesis provides a richer and deeper understanding of the role of trust in innovation ecosystems and its effect on the actors' innovation performance, towards improving actors' innovation performance.

5. Final considerations

Innovation ecosystem has been a research topic of interest in the past few years, which has made of it a rasing topic both in literature and industry (Gomes et al., 2018; Granstrand & Holgersson, 2020; Ritala et al., 2013; Su, Zheng & Chen, 2018). However, there is still a gap of researches that consider the relationships among actors and the dynamics of innovation ecosystems (Hakala et al., 2019; Paasi et al., 2023; Sant'Ana et al., 2020). Given this backdrop, the objective of this study was to comprehend the role of trust among actors in innovation ecosystems and its effect on the actors' innovation performance.

The study was applied in the context of four innovation ecosystems from the south of Brazil, due to its recent and potential growth. We analyzed a sample of 121 valid responses and tested nine hypotheses related to the theoretical model proposed. The objective of this thesis was achieved, with the theoretical deepening of the subject and the empirical tests, analyzed by quantitative techniques, such as descriptive statistics and structural equation model. Understanding the influence of trust in innovation ecosystems can contribute to increasing the involvement and commitment of parties, to facilitate information exchange and to reduce risk perception, which will have an impact on the actors' innovation performance. This has resulted in relevant academic contributions to the field of innovation ecosystems, allowing us to raise several conclusions.

First, the study brings some academic novelty by proposing the four dimensions of the innovation ecosystems. Through a search in the literature for the most relevant studies on the topic of innovation ecosystems, we suggested that this phenomenon is mainly composed of four constructs, denominated dimensions: network collaboration, interdependence, value co-creation and innovation orientation. Second, we found that trust positively influences these four proposed dimensions of innovation ecosystems. Such conclusions highlight the significance to build relationships among actors based on trust in order to optimize the dynamics of the innovation ecosystem.

Third, it was also possible to test the influence of the four dimensions of innovation ecosystems on the actors' innovation performance, and results showed that network collaboration, interdependence and innovation orientation positively influence the actors' innovation performance. Therefore, it is expected that actors of the innovation ecosystem center their relations of trust in these three dimensions, which will further bring them benefits in terms of innovation performance. Value co-creation was the only dimension that did not have a direct

effect on the actors' innovation performance. It was shown that this relation is controversial in the literature. Hence, the results of this research strengthens the need to disentangle this relationship in order to analyze if there really are mediating variables ensuring the effect of value co-creation on innovation performance and to find out which are they.

Fourth, it was found that trust does not have a significantly direct effect on the actors' innovation performance. However, through an indirect effect analysis, results showed that the relationship between trust and the actors' innovation performance is completely mediated by network collaboration, innovation orientation and interdependence. Such conclusion emphasizes the relevance of the theoretical model proposed in this research and strengthens the innovation ecosystem dimensions suggested in the theoretical background of this study. This means that there is a need for the dimensions of the innovation ecosystem to be emphasized, because they mediate the relationship between trust and the actors' innovation performance.

This study also brings methodological contributions by using serial mediation in analyzing the influence of trust in innovation ecosystems, while few studies have used this method so far (Wang, Su & Zhang, 2023; Zhang, Wang & Xu, 2021; Wei et al., 2021; Soral et al., 2023). The application of partial least square structural equation models represents an effort to raise the precision and rigor with which concepts involved in this research are treated in literature.

Additionally, this research has some relevant implications for managers who seek to improve the organizations' connections in the innovation ecosystem they participate. First, findings showed that organizations can achieve more benefits if they build trustworthy relationships in the innovation ecosystem. Thus, managers should center their efforts in becoming a reliable partner through ability, benevolence and integrity, which are the three dimensions of trust, because the more actors trust each other, the greater the exchanges, ideas and innovations will be. Besides that, by combining and integrating ideas from multiple types of actors thinking from different perspectives, organizations can improve product innovation, and as a result boost innovation performance. Second, actors that participate in innovation ecosystems should develop mechanisms to share knowledge, information and resources, because these actions of sharing are essential to the existence of the four innovation ecosystem dimensions. Therefore, managers must ensure that their organizations are capable of that in order to make the most of being part of this powerful network.

Third, it is relevant to consider that even though value co-creation did not have a positive direct effect on innovation performance, the findings revealed that this construct

proved to be an essential dimension for the construction of the innovation ecosystem. Therefore, managers should do more efforts in developing this dimension inside organizations, with the aim to take advantage of all the benefits it can generate to each actor of the ecosystem. Fourth, since the responses of this research coming from government institutions had a small representation (1.65%), governmental managers can focus on creating public policies to improve the operation of the dimensions of the innovation ecosystem, in order to involve this type of organization in joint initiatives that are part of their environments.

Regardless of the results found, there are some limitations of the research that need to be taken into account, which may result in suggestions for future studies. Our research is based on an online questionnaire, which can be advantageous for agility and low cost of application. However, in online surveys, there is the absence of the researcher at the exact time of the responses and it may result in a sort of bias, because of the respondents' lack of attention. This also represents a future opportunity for researchers to run other empirical studies that collect more response from innovation ecosystem actors. Future studies can include, in addition to the online survey application, qualitative and face-to-face interview with the respondents or focus groups, in order to add robustness to the results.

Future studies could use research designs such as qualitative case study or qualitative comparative analysis to investigate how trust among actors in innovation ecosystem influence innovation performance, in order to compare quantitative and qualitative methods of data collection in specific contexts.

Additionally, the specific context of the study being technological parks from the south of Brazil may also influence findings and conclusions in a way that can challenge the generalizability. We suggest that future research replicate this study in other countries or in a multinational context. It would also be interesting if further efforts analyze the theoretical model proposed by this research in different lifecycle stages of the innovation ecosystem, in order to verify the effect of each dimension in the different stages of the ecosystem.

Besides that, this study focuses on all the actors of the innovation ecosystems analyzed. Future studies could analyze the role of trust in innovation ecosystem focusing on a specific actor of the quadruple helix in each research, to check if results are similar to each other.

Our study has not focused in developing a specific measurement instrument for trust among actors in innovation ecosystems, but instead on identifying possible indicators that influence trust among actors in innovation ecosystems. Thus, upcoming studies could develop

an instrument to measure the level of trust among actors in multiple ecosystems, in order to compare the level of trust in the ecosystem and its innovation performance.

Finally, considering that H7 was not supported, indicating that value co-creation does not positively influence innovation performance, future studies could focus on discovering which elements might mediate this relationship in the context of innovation ecosystems. Similarly, since H9 was also not supported, indicating that trust does not directly positively influence innovation performance, researchers can focus on exploring the reasons why the actors did not perceive such relation as a direct one.

Overall, actors of innovation ecosystems can no longer solely be part of an ecosystem. If they need to gain superior innovation performance, they need to truly interact with other players and build relations based on trust, aiming to effectively collaborate with their network, have mutual dependence on others and prioritize innovation orientation. These outcomes provide new insights for the field and reinforce the relevance of trust among actors in innovation ecosystems.

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Appendix 1. Measurement of Trust

Adapted from McKnight et al. (2002)

Ability:

1.Actors of the innovation ecosystem are competent and effective in doing their business.

2.Actors of the innovation ecosystem perform their role in the ecosystem very well.

3.Overall, the actors of the innovation ecosystem are capable and proficient in doing their business

4. In general, the actors of the innovation ecosystem are very knowledgeable about their business.

Benevolence:

1.I believe that the actors of the innovation ecosystem would act in my best interest.

2. If I required help, the actors of the innovation ecosystem would do their best to help me.

3. The actors of the innovation ecosystem are interested in my well-being, not just their own.

Integrity:

1. The actors of the innovation ecosystem are truthful in their dealings with me.

2. I would characterize the actors of the innovation ecosystem as honest.

3. The actors of the innovation ecosystem keep its commitments.

4. The actors of the innovation ecosystem are sincere and genuine.

Appendix 2. Measurement of Network Collaboration

Adapted from Sorenson et al. (2008)

When considering your relationship with other actors of the innovation ecosystem, answer the following:

1. We exchange accurate information to solve the problem together.
2. We try to bring all our concerns out in the open so that the issues can be resolved in the best possible way.
3. We try to work with one another for a proper understanding of the problem.

Appendix 3. Measurement of Interdependence

Adapted from Campion et al. (1993)

When considering your relationship with other actors of the innovation ecosystem, answer the following:

1. We cannot accomplish some of our company's activities without information or materials from other actors of the innovation ecosystem.
2. Other actors of the innovation ecosystem depend on our company for information or materials needed to perform their activities.
3. Within the innovation ecosystem, activities performed by actors are related to one another.

Appendix 4. Measurement of Value co-creation

Adapted from Dahlin et al. (2020)

When considering your relationship with other actors of the innovation ecosystem, answer the following:

1.Overall, involving actors of the innovation ecosystem in our activities has been a success.
2.The contribution of various actors of the innovation ecosystem has been vital for developing our products/services.
3.Our products and services that have been developed considering other actors' participation and knowledge have been accepted by the market.

Appendix 5. Measurement of Innovation Orientation

Adapted from Lii & Kuo (2016)

Consider the organization you work for to answer the following questions:

1. The organization I work for pays close attention to innovation.
2. The organization I work for emphasizes the need for innovation for development.
3. The organization I work for promotes the need for development and utilization of new resources.
4. The organization I work for embraces, accepts, and measures innovation.
5. The organization I work for actively seeks innovative ideas.
6. The organization I work for encourages people for new ideas even if they don't work.

Appendix 6. Measurement of Innovation Performance

Adapted from Zhang & Li (2010)

Consider the organization you work for to answer the following questions:

1. The organization I work for frequently introduces new products.
2. The organization I work for is often the first in new product introductions in the market.
3. The organization I work for quickly launches new products into the market.
4. The organization I work for develops new products with superior quality.
5. The organization I work for uses new products to penetrate markets.

Appendix 7. Questionnaire in Portuguese

Identificação do ator do Ecossistema
a) Qual o setor de atuação da sua organização?
b) Qual o tempo de existência da organização (em anos)?
c) Qual o tempo de atuação da organização no ecossistema Tecnopuc (em anos)?
d) Qual o número de colaboradores da organização?

Bloco 1

Considere os **atores** do ecossistema de inovação Tecnopuc para responder às seguintes questões:

Atores incluem: parque tecnológico, instituições de ensino, instituições de pesquisa, institutos de ciência e tecnologia, instituições de fomento, centros de inovação, coworkings, hubs de inovação, governo, investidores, aceleradoras, incubadoras, empresas, startups, prestadores de serviços, associações, comunidade, entre outros.

1. Os atores do ecossistema de inovação são competentes e eficazes na condução de suas atividades.
2. Os atores do ecossistema de inovação desempenham muito bem seu papel no ecossistema.
3. Os atores do ecossistema de inovação são capazes e qualificados para conduzir suas atividades.
4. Os atores do ecossistema de inovação são muito conhecedores das suas atividades.

5.Acredito que os atores do ecossistema de inovação agiriam no meu melhor interesse.
6. Se eu precisasse de ajuda, os atores do ecossistema de inovação fariam o possível para me ajudar.
7. Os atores do ecossistema de inovação estão interessados no meu bem-estar, não apenas no deles.

8. Os atores do ecossistema de inovação são verdadeiros em suas relações comigo.
9. Eu caracterizaria os atores do ecossistema de inovação como honestos.
10. Os atores do ecossistema de inovação cumprem seus compromissos.
11. Os atores do ecossistema de inovação são sinceros e genuínos.

Bloco 2

Agora considere o seu **relacionamento com os atores** do ecossistema de inovação Tecnopuc para responder às seguintes questões:

12. Trocamos informações precisas para resolver problemas juntos.
13. Tentamos trazer as nossas preocupações aos outros atores para que os problemas possam ser resolvidos da melhor maneira possível.
14. Tentamos trabalhar uns com os outros para uma compreensão adequada do problema.

15. Para realizar algumas atividades de nossa organização, precisamos de informações ou materiais de outros atores do ecossistema de inovação.
16. Outros atores do ecossistema de inovação dependem de nossa organização para obter informações ou materiais necessários ao desempenho de suas atividades.

17. Dentro do ecossistema de inovação, as atividades realizadas pelos atores estão relacionadas entre si.

18. O envolvimento dos atores do ecossistema de inovação em nossas atividades tem sido bem sucedido.
19. A contribuição dos diversos atores do ecossistema de inovação tem sido fundamental para o desenvolvimento dos nossos **produtos**.
De acordo com sua instituição, produtos podem ser: bens, serviços, políticas públicas, parcerias, editais, programas, eventos, capacitações, assistências, pesquisas, etc.
20. Nossos **produtos** desenvolvidos com a participação e o conhecimento de outros atores têm sido aceitos pelo mercado.
De acordo com sua instituição, produtos podem ser: bens, serviços, políticas públicas, parcerias, editais, programas, eventos, capacitações, assistências, pesquisas, etc.

Bloco 3

Por fim, considere a **organização em que você trabalha** para responder às seguintes perguntas:

21. A organização em que eu trabalho valoriza a inovação.
22. A organização em que eu trabalho enfatiza a necessidade de inovação para o desenvolvimento.
23. A organização em que eu trabalho promove a necessidade de desenvolvimento e de utilização de novos recursos.
24. A organização em que eu trabalho envolve, aceita e mede a inovação.
25. A organização em que eu trabalho procura ativamente ideias inovadoras.
26. A organização em que eu trabalho incentiva as pessoas a terem novas ideias, mesmo que não funcionem.

27. A organização em que eu trabalho frequentemente desenvolve novos **produtos**.
De acordo com sua instituição, produtos podem ser: bens, serviços, políticas públicas, parcerias, editais, programas, eventos, capacitações, assistências, pesquisas, etc.
28. A organização em que eu trabalho é frequentemente a primeira a introduzir novos **produtos** no mercado.
De acordo com sua instituição, produtos podem ser: bens, serviços, políticas públicas, parcerias, editais, programas, eventos, capacitações, assistências, pesquisas, etc.
29. A organização em que eu trabalho lança rapidamente novos **produtos** no mercado.
De acordo com sua instituição, produtos podem ser: bens, serviços, políticas públicas, parcerias, editais, programas, eventos, capacitações, assistências, pesquisas, etc.
30. A organização em que eu trabalho desenvolve novos **produtos** com qualidade superior à de organizações semelhantes.
De acordo com sua instituição, produtos podem ser: bens, serviços, políticas públicas, parcerias, editais, programas, eventos, capacitações, assistências, pesquisas, etc.
31. A organização em que eu trabalho usa novos **produtos** para penetrar nos mercados.
De acordo com sua instituição, produtos podem ser: bens, serviços, políticas públicas, parcerias, editais, programas, eventos, capacitações, assistências, pesquisas, etc.

Appendix 8. G*Power sample calculation

