The role of Institutions in a Regional Innovation System and their impact on the

Innovation Performance of Organizations within the Quadruple Helix.

By

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Dedication

I dedicate my dissertation work to all the people that supported and encouraged me along the way. So many lovely people touched my life during these four years, and helped me in so many ways, that I have not enough space to mention each one. I hold a special feeling of gratitude to my husband, who gave me a new appreciation for the meaning and importance of love and friendship, to my mother for her encouragement, love and emotional support during stressing periods, and to my father and my brother, as I will always appreciate all they have done for me in my life.

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Abstract

Among the critical issues facing policy and decision makers is how to improve the regional innovation systems (RISs). Such improvement enhances the balanced development of organizational innovative capacities, encourages innovation performance (IP), and consequently helps achieve sustainable economic development. The empirical study adds to the literature and improvement of regional innovation systems approach by characterizing the institutional framework of an RIS, describing the role of formal and informal institutions, and assessing their impact on the IP of organizations within the Quadruple Helix. The RIS of Medellin was used as an instrumental case study, and the research was conducted using a qualitative, cross-sectional design, with semi-structured interviews as data collection method and thematic analysis as data processing method. Managerial and policy implications of the findings are revised, and directions for future research are offered.

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Chapter 1: Introduction

Innovation is widely accepted as essential for the growth of productivity and certainly has an essential role for economic and social progress; however, the understanding of innovation activities and their economic impact still lacks clarity (OECD, 2005). In order to understand this phenomenon, the research on innovation may adopt the systemic perspective or the management perspective (Mazur & Inków, 2017). The systemic view of innovation considers the importance of the network for the innovation process and the importance of the set of organizations and institutions interacting within a system for achieving innovation (Audretsch et al., 2002; Audretsch & Feldman, 2004; Belussi, Sammarra, & Sedita, 2010; Metcalfe, 2005). In this line, the innovation economics approach is the one related to the study of innovation systems (IS) (Antonelli, 2003; Johnson, 2008) and when considering the innovation systems perspective one can find different approaches as the technological, sectoral, national, and regional. According to Niosi (2010), the "countries possessing national and regional innovation systems in specific sectors will become wealthier" (p. 43). Academics have lately and progressively emphasized on the study of regional innovation systems, highlighting their importance and relevance in the current scenario (Blažek et al., 2013; Cooke, 2002; Iammarino, 2005), also the regional approach is crescent in importance in comparison with other versions of IS (Asheim & Coenen, 2005; Cooke, Boekholt, & Tödtling, 2000).

Iammarino (2006) conceptualized a regional innovation system (RIS) in terms of a "localized network of actors and institutions in the public and private sectors whose activities and interactions generate, import, modify, and diffuse new technologies within and outside the region" (p. 499). RISs are expected to increase the innovation performance (IP) of the organizations within the system, generating a positive impact no only at an individual or organizational level, but at the meso and macroeconomic level. The IP refers to the outputs or

results of the innovation activities (OECD, 2005) and according to the Oslo Manual (OECD, 2015) measures of IP include the results related to product innovation (goods and services), process innovation, organizational innovation, and marketing innovation.

Some studies have focused on innovation systems from Latin American countries and regions (Alcorta & Peres, 1998) and some of those, explored the role and significance of institutions for the innovation activity and IP of the organizations interacting within the innovation system (Ghazinoory, Riahi, Azar, & Miremadi, 2014). While "most of the literature on innovation has focused on its determinants, such as foreign direct investment […], and human capital, few studies have considered the role of institutional environment in innovation" (Lee & Law, 2017, p. 203), additionally there have been calls for research on the importance of subnational institutions in facilitating or constraining region-specific exchanges and alliances among different actors of the system (Kafouros, Wang, Piperopoulos, & Zhang, 2015). This information is crucial, as according to the OECD (2007), policymakers must have the appropriate tools to be able to adapt the regulatory framework to the requirements of the innovation systems and to encourage the development of the knowledge and innovation economy.

In order to help fulfill the academic and practical knowledge gaps mentioned before, this research used a qualitative approach to describe the role of institutions of an RIS for the organizations' IP, using the Medellin's RIS as an instrumental case study. This case is appropriate to enlarge the information about the role and importance of institutions for the organizations' IP within the system, because of several reasons. One of them is that the Urban Land Institute (ULI) declared Medellin the "Innovative City of The Year" in the 2013 Citi Global Competition by the Wall Street Journal (Moreno, 2013). The region is also currently developing a highly structured process to enhance the RIS, under an integral transformation project called Medellinnovation (Medellinnovation, 2016) which has been

based on a benchmark of the best practices of innovations systems worldwide (E. Echeverri, personal communication, June 14, 2015). In 2017, the New York-based Institute for Robotic Process Automation and Artificial Intelligence (IRPA-AI) announced a deal with Ruta N, by which the IRPA-AI will help launch a program called the "Digital Americas Pipeline Initiative" (DAPI) in Medellin (Peckham, 2017). According to Peckham (2017) Medellin's 'Ruta N' Inks Robotics, Artificial-Intelligence Development Deal. Medellin Herald. Retrieved from http://medellinherald.comDAPI "aims to trigger more research and development in automation and AI, to enable analytics, Internet of Things and cloud computing" in order to generate innovation, new jobs and socioeconomic growth in Medellin All this factors support the valuable vision that it might provide when making an analysis of the proposed phenomenon. This study does not attempt to deliver all the answers related to the institutional environment and how it relates with the IP or the organizations within an RIS, but it makes an important contribution to the subject in themes and areas that the current literature has not yet addressed exhaustively, and provides a foundation for the elaboration of appropriate measures in the future.

Background of the Problem

Schumpeter is on one of the most well known authors in addressing the topic of innovation, and in 1947, the author highlighted the importance of innovation for the economic development in his academic article "The Creative Response in Economic History." The concept of innovation gained great interest during the 1980s, and Schumpeterian ideas constituted part of the support for the study of innovation from a systems perspective, which emphasizes the role of institutions (Carlsson, 2006). Porter is another important and well-recognized seminal author on innovation and in late 90's he focused on the analysis of the innovation within clusters instead as isolated phenomenon is his work "Clusters and competition: new agendas for companies, governments, and

institutions" (Porter, 1998). Later the knowledge in the field advanced towards more sophisticated and deepen theoretical approaches, and the innovation economics (IE) field gained importance, pointing out to the relevance of innovation for the sustainable development and the economic growth (Courvisanos & Mackenzie, 2014; Guan & Chen, 2012; Johnson, 2008; Pekkarinen & Harmaakorpi, 2006). Within the innovation economics approach, the innovation is analyzed from an interdependent and systemic approach, as a system of relations and interactions between different actors (Tödtling & Kaufmann, 1999). The first systemic perspective to be developed was the national innovation system (NIS), first proposed by Freeman in 1982 (Watkins, Papaioannou, Mugwagwa, & Kale, 2015) and further developed in the early 90's by Lundvall (1992) and Nelson (1993). Since the publication of the first literature on NIS, there was a desire of developing a comparable conceptual approach in smaller geographical levels, like regional or local environments (Breschi, 2000; Cooke et al., 1997; Howells, 1999).

As it became evident that national comparative advantage was often based on subnational levels of specialization, the regional level attained more interest from academics and policymakers who recognized the value in the study of certain arrangements of institutional, behavioral, and financial configurations of different innovative regions (Cooke, Uranga, & Etxebarria, 1997). In addition, according to the crescent interest and the literature development, the most important concept is nowadays the regional innovation system; a concept first formally introduced by Cooke, Uranga and Etxebarria in 1997. The articles written in the first decade were mainly focused toward the theoretical conceptualization of the RIS, while the more recent research have mostly focused on processes leading to tangible innovation outcomes (e.g. Henttonen, Ojanen, & Puumalainen, 2016; Kim, 2014; Mazur & Inków, 2017). According to Lee and Law (2017) a "further examination of the impact of different institutional dimensions (e.g. governance and social capital) on innovative activity

might explain the current disparity in countries innovations level which might then invalidate the fundamental concept of world technological convergence" (p. 204). In relation to the selected approach (RIS), it is interesting to notice that in the last five years the number of articles of RISs published in academic journals exceeds the total amount of the articles published since the first apparition of the topic in 1997, as is shown in Table 1.

Table 1

Published Articles of Regional Innovation Systems since 1997

Journal	1997-2000	2001-2005	2006-2010	2011-2016	Total	%
European Urban And Regional Studies	2			2	4	5
Regional Studies	1	4	5	9	19	25
Research Policy	1	3	2	1	7	9
Scientometrics		1	2	1	4	5
Technovation		2	1	1	4	5
European Planning Studies		4	6	14	24	31
Entrepreneurship And Regional Development			1		1	1
Technological Forecasting And Social Change			1	10	11	14
Economic Development Quarterly				1	1	1
Industry And Innovation					1	1
European Journal Of Innovation Management				1	1	1
Total	4	14	18	40	77	100

As seen, there is evidence of the importance of the study RISs, in both academic and practical terms, and of the appropriateness of using Medellin's RIS as a case within a context useful to gain a better knowledge of the different aspects of the institutions within the innovation systems and their interaction and influence over the organizations' IP.

Statement of the Problem

The institutions and the institutional framework is a significant factor influencing firms' innovation activity and performance (Larionova, Zagaynova, & Abramova, 2014;

Kwon & Motohashi, 2016). Although the leading authors on innovation economics, including Romer, Helpman, Arthur, Axtell, Nelson, Lipsey, Porter, Freeman and Yegorov, recognize the fundamental importance of institutions in innovation systems (Johnson, 2008), there is a need to further understand the diverse forms of institutions, the role of those institutions, and their relations with organizations interacting within the system (Funk, 2014). Padilla-Perez, Vang and Chaminade (2009) expressed that while some researches have provided valuable knowledge about the role of RIS in assisting IP in developing countries, important methodological and theoretical gaps are evident. The key questions arising from the statement that institutions influence innovation are how they are related to IP and which institutions are most important for explaining innovative activity (Zoogah, Peng, & Woldu, 2015) and it "is very important to have a consistent framework of institutions and no discrepancy between formal and informal institutions" (Tridico, 2013, p. 19). All of these questions continue to be at the core of the practical and institutional understandings of innovation systems, as they are of key to the social and economic progress in the context of contemporary economical dynamics (Kriaučionienė, 2008). Firms are commended to innovate if they want to increase and expand a competitive advantage, as the survival of organizations nowadays largely depends on the capability to be innovative (Courvisanos & Mackenzie, 2014). Science, technology and innovation policymakers are facing the challenge of finding how to foster and enhance innovation and fully recognize the relevance of having strong institutions that improve interactions among different actors to promote innovative activity and performance (OECD, 2015; Villasana & Chavez, 2012).

Purpose of the Study

The purpose of this study was to understand the role of formal and informal institutions in the innovation process, and how they affect IP of formal and informal organizations within the RIS of Medellin. To solve the problem identified, a descriptive,

cross-sectional, qualitative research study was applied using an instrumental case study. The main variables to observe within the study were the formal and informal institutions (institutional framework) related to the RIS's functioning and the organizations' innovative performance.

Qualitative analysis of data collected from interviews were performed during the second semester of 2018, supported by the usage of ATLAS.ti 7 for Windows, a qualitative data analysis software. The qualitative approach was appropriate for this study in view of the current state of the art of the topic and the lack of an appropriate measurement instrument that would be already validated and widely applied for the measurement of formal and informal institutions. Finally, the researcher counted on the support of ANDI and Ruta N, two of the most important and well recognized organizations operating as innovation intermediaries at the core of Medellin's RIS. Both, the ANDI (*Asociacion Nacional de Empresarios de Colombia*) and Ruta N are governmental agencies, operating public resources to escalate the IP of the regional innovation system.

Significance of the Study

Innovation economists assured that in today's knowledge-based setting, innovative capacity is the main driver of economic and social development, as well as the structures and policies allowing for innovation, instead of capital accumulation, as said by neoclassics (Antonelli, 2003), as well as the existence of systems of innovation pushing innovative environments (Johnson, 2008). Innovation has always represented and importance source of strength for economies, regions and firms, and is an essential prerequisite for understanding economic growth (Garud, Tuertscher, & Van de Ven, 2013). According to Asheim and Coenen (2005), innovative activities and the economic geographies that contribute to the efficiency and effectiveness of knowledge links are crucial to development. Also, innovation in and from developing economies has become a significant component of the global

innovative output because it enhances firms' competitiveness to attain success in the global market place (Kumar, Mudambi, & Gray, 2013).

The valuable contribution of this study to innovation theory will lie in the acquisition of new evidence about the role of the institutions and the institutional framework on IP, using a case of a Latin American country. Also, the results of the research will allow for the generation of useful information, not only relevant for the academic field but for the regions seeking to generate and enhance RIS´s innovative activity and performance, as it will provide convenient information for the design and implementation of strategies at the institutional level. Strategies designed with appropriate foundations will allow RISs actors, especially those sharing similar characteristics with Medellin´s RIS, in their goal to increase IP levels and achieve social and economic development.

Nature of the Study

This basic descriptive research was conducted using a qualitative, cross-sectional design, applying an instrumental case study as methodology, semi-structured interviews as data collection method and TA as data processing method. For the data collection, 27 innovation managers within the selected organizations of the Medellin's RIS were interviewed during the second semester of 2017; as a method for data analysis a thematic analysis (TA) was made with the purpose of identifying and analyzing the specific formal and informal institutions operating in the RIS, and their role for the IP. After the categorization and codification of the data, graphical analysis were performed in order to support the TA and conclusions. Spider graphs were obtained from the codified and structured data in order to visually asses the phenomenon and to help deepen the research question answers. The study was basic in nature as the main purpose of the research was to advance in knowledge, extending the state of the art and helping to fill the current knowledge gap.

In the innovation process, the interaction among institutions and organizations is essential, as it permits knowledge flow and collaboration (Edquist, 2001), but when it comes to the study of the role of RIS in supporting these interactions and the IP, theoretical and methodological gaps are still significant; especially in those cases of developing countries (Padilla-Perez, Vang, & Chaminade, 2009). The descriptive approach in the study was considered appropriate, as it allows establishing priorities and developing concepts more clearly, as well as their operational definitions, acquiring new insights useful to formulate precise hypotheses for more definite studies in the future (Shields & Rangarajan, 2013). In addition, according to Gerring (2004), the case study, understood as an intensive research or study of a single unit, may serve for the "purpose of understanding a larger class of similar units" (p. 342), and specifically the instrumental case study is used to "accomplish something other than understanding a particular situation. It provides insight into an issue or helps to refine a theory" (Baxter, & Jack, 2008). The TA is advantageous as it allows researchers to extend previous studies, and it is appropriated in studies where questions and goals go beyond an individual understanding or single perspective, letting new categories to materialize from data (Braun & Clarke, 2006; Guest, MacQueen, & Namey, 2011).

Semi-structured interviews were used as method for data collection and 27 interviews were done, until theoretical saturation of data was achieved. Theoretical saturation happens when no new codes are founded with successive data analysis (Strauss & Corbin, 1998). The qualitative data collected was organized into hermeneutical units using ATLAS.ti 7 for Windows, which is an appropriate software for qualitative data exploration and for TA implementation (Silver & Lewins, 2014). The units of analysis, within the case study, were the formal and informal organizations interacting within the RIS of Medellin, while the units of observation were the employees managing innovation departments within those selected organizations.

The proposed research methodology, along with the data collection and processing methods, allowed the generation of the information necessary to understand the role of institutions on the IP of the formal and informal organizations within the RIS. It is important to clarify that, even though in the early versions of this proposal a quantitative approach was considered, in order to quantitatively asses the relation between institutions and IP, the literature review for the study revealed that there is not yet a reliable measurement instrument to quantify the variables. Empirical research on the subject to date is mostly based on qualitative exploratory approaches, as is supported in the next chapter, which presents the literature review for the study.

The case of Medellin's RIS is appropriate for this study as it enlarges the current knowledge of the topic in general, and especially for the context on Latin American countries. As supported before, Medellin is a city that has experienced a remarkable growth in terms of innovation activities, and the city as well as the connecting organizations of the RIS have been recognized with significant awards by diverse important entities around the world (ACI, 2014; Fast Company, 2018; Moreno, 2013).

This study contributes to the existing literature allowing empirical support to new knowledge about institutions and their role in innovative performance, and RISs, in conceptual and theoretical terms. Future research may consider the development of quantitative longitudinal studies, but for the current research, cross-sectional design was more appropriate considering the current state of the art and the scope of the study.

Research Questions

The leading authors on the field of innovation have long recognized the fundamental importance of institutions on innovation systems (Johnson, 2008), but according to Funk (2014) there is a need to develop further research about the kind of institutions, the role of those institutions, and the relation of institutions with organizations interacting within the

system, for the enhancement of the IP. As shown in the literature review various authors have commented on the importance of acquiring better knowledge on these issues, as it will allow for the formulation of better policy settings and effective incentive strategies, from the perspective of both formal and informal institutions, in order to stimulate the IP of the organizations within the RIS.

The main research question derived from the problem statement, the state of the art and the knowledge gap, which this dissertation was intended to answer was: What is the role of formal and informal institutions in an RIS for the IP of the organizations within the quadruple helix?

As this main research question proposed could not be answered all at once, it was broken down into specific questions. The following specific questions or sub-questions were important as they allowed answering the main question in a systematic manner:

1. Why the institutional framework plays an important role in an RIS?

2. Which formal institutions influence the IP of the organizations within an RIS?

3. Which informal institutions influence the IP of the organizations within an RIS?

4. Which institutions are expected to positively influence the IP of the organizations? Within an RIS? Why?

5. Which institutions are expected to negatively influence the IP of the organizations? Within an RIS? Why?

Theoretical Framework

While academics admit the usefulness and relevance of innovation and innovation systems in the development of regions and countries, there are different views of innovation systems, and diverse approaches to the study of institutional frameworks in the literature. The theories used (see Figure 1) provided research direction, as this study built up on previous

knowledge, also the appropriate theoretical approach evidence that this research is grounded in and based on scientific theory.

Literature has extended to include multiple dimensions in the innovation economics theory including aspects related to the RIS, the institutional change and the economic and industrial dynamics (Bartels, Voss, Lederer, & Bachtrog, 2012). In the 1980s the concept of IS was introduced, with the purpose of emphasizing the interconnection between the technical and the institutional evolution in the process of economic and social development (Edquist & Hommen, 1999). According to Johnson, (2008), the IP can be better analyzed within a systemic and dynamic context, because the results of an economy depends not only on how individual firms and organizations perform, but also on how they cooperate and relate with each other and with the government, academic and financial sectors (Johnson, 2008). According to Johnson (2008) when analyzing economic dynamics and innovation systems, there are narrow and broad approaches.

In the narrow version, high-tech activities, research and development systems are at the core of the model; while the broad approach sees innovation as part of every kind of activities and functions of firms, including procurement, fabrication and promotion, and also innovation is recognized to occur in various types of sectors, organizations and firms. In this interactive and interrelated settings of the broad version of IS, the concept of RIS emerged, recognizing that the innovation process in general tends to be highly localized (Cooke, 2002).

It is important to acknowledge that the RIS concept has different related terms, as for example the industrial clustering or regional clustering (Cooke, 2001); and, in some countries, such as the United States and Japan, the term cluster prevails over the term RIS (Motohashi, 2005; Pohl & Yarime, 2012; Storz, 2008).
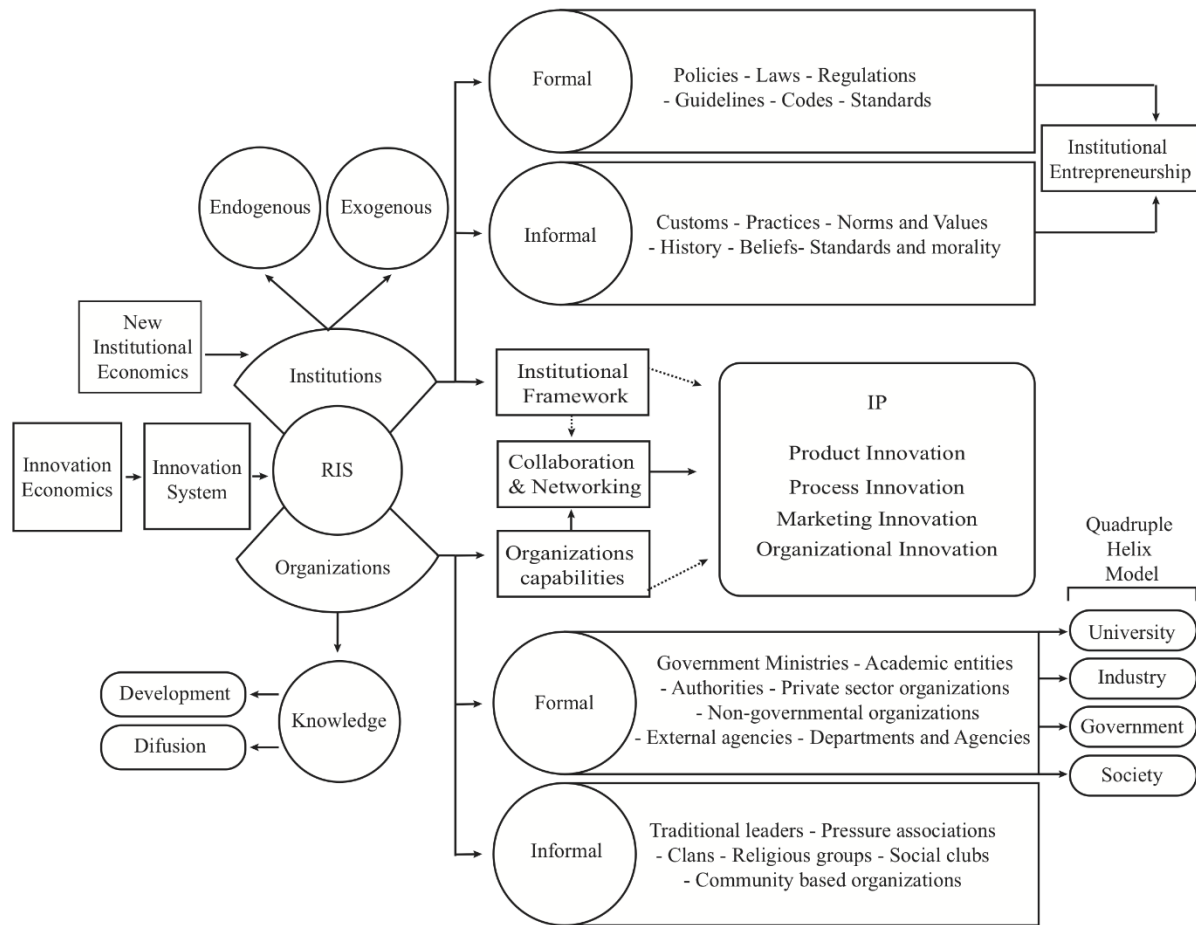
Figure 1. Theoretical Framework Map.

The IP of any innovation system (IS) would be the sum of the IP of all the organizations interacting within it (Cooke et al., 1997) and the innovative capability of the IS is affected by (a) what is being produced; the sector, (b) by where it is being produced; the localization, (c) by how it is being produced; the interactions, and (d) by institutions and institutional framework (Johnson, 2008). There are four dominant authors who have studied and conceptualized the institutional approach, which are Douglass North, Richard Scott, Walter Powell, and Paul DiMaggio. According to North (2005), institutions and institutional framework affect the social and economic progress, and the institutions can be either formal (e.g. constitutions, contracts and regulations), or informal, (e.g. attitudes, values, norms of behavior and conventions). According to Scott (2004), the institutional approach emphases

on the profounder and resistant features of social configurations, considering the processes by which arrangements, including structures, directions, rules, and procedures, grow into conventional influential guiding principles for common conduct, seeing institutions as (a) cultural-cognitive, (b) normative, and (c) regulative. According to Asheim and Coenen, (2005), DiMaggio and Powell rejected the rational-actor models of classical economics, focusing on sociology aspects of institutions and seeking cognitive and cultural explanations for social and organizational phenomena.

These several variations and usages of the concept of institutions will be explored more in depth in the literature review, but due to its clarity of definition, North's taxonomy of institutions was adopted as the basis of this study. North's (1991, p. 97) distinguishes between: (a) informal constraints (e.g. principles, prohibitions, habits, customs, and conduct codes), and (b) formal rules (e.g. policies, regulations, laws, formal rules and rights). According to North (2005), the most important function of institutions in a social system is to moderate ambiguity by establishing a steady scheme for social relations. Formal institutions are created, announced and implemented through generally accepted official channels; as courts of law, parliaments, administrations, and governments, whereas informal institutions are informally shaped guidelines, usually unrecorded, that are generated, pronounced and applied apart from official channels (Helmke & Levitsky, 2004).

The application of new institutional economics theory is especially helpful to understand how innovation among firms depends largely on intrinsic settings, and how collaborative arrangements and knowledge management have a crucial role for the vitality of regional economies (Funk, 2014). The distinctive performance of diverse regions is an outcome from the linkages between organizations and the institutions relating them (Whittington, Owen-Smith, & Powell, 2009), while this relationships among actors in an IS, constitute a dynamic social network structure, in which the quality of relationships influences

the viability of the IS (Agapitova, 2005). However, it is interesting to see how even between

relatively effective regions these systemic configurations may differ extensively in

institutional frameworks and interactions (Owen-Smith & Powell, 2004). Scott (1995)

observed that although "all organizations within a given institutional field or sector are

subject to the effects of institutional processes within the context, all do not experience them

in the same way or respond in the same manner" (p. 161).

Definition of Terms

This research use concepts related to the innovation economics theory and the new

institutional economics (NIE) theory. The relevant concepts for the study were clearly

defined in order to answer the research questions by following an appropriate structure, while

maintaining terminology and theoretical coherence.

The *innovation economics* (IE) theory, points out that innovative capacity encouraged

by knowledge acquisitions and technological capabilities is what primarily drives economic

growth in today's knowledge-based systems (Antonelli, 2003). For IE theorists, economic

growth is the consequence of knowledge production and transfer, laws allowing for

innovation and entrepreneurship, technological spillovers, collaboration between

organizations and ISs that facilitate innovation culture (Johnson & Bjorn, 2008).

The term *innovation* refers to "the implementation of any new or significantly

improved product (goods or services), operational processes (methods of production and

service of delivery), any new marketing methods (packaging, sales and distribution methods),

or new organizational or managerial methods or processes in business practices" (OECD,

2005, p. 46).

Innovation systems (ISs) refers to the actors that participate in the creation, dispersion

and usage of novel and valuable products, process and knowledge, and as well to the

connections among the local institutions, which encourages and enables technological development and innovations (Lundvall, 1992).

A *regional innovation system* is a "localized network of actors and institutions in the public and private sectors, whose activities and interactions generate, modify and diffuse innovations within and outside the region" (Iammarino, 2006, p. 499).

An *innovation* is "the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organization or external relations. A common feature of an innovation is that it must have been implemented" (OECD, 2005). In addition, "A new or improved product is implemented when it is introduced on the market. New processes, marketing methods or organizational methods are implemented when they are brought into actual use in the firm's operations" (OECD, 2005).

The *new institutional economics* (NIE) theory examines how the institutions function in defining means through which the players of the economic arena interact, adjusting the rationality of behavior in human beings, the information asymmetry, and the transaction costs (North, 1992). The *institutions* are "the humanly devised constraints that structure human interaction" (North, 1992, p. 3).

The *exogenous institutions* are those that affect organizations from outside and are forced on them with limited control from the member of the organisation, and *endogenous institutions*, are those that naturally change with the organizations progress, and may adjust because of the knowledge and learning process inside the organization (Rolfstam, 2009).

In relation to innovation, the *informal institutions* are the social standards in the behavior of actors concern morality, level of civic culture, economic intelligence, human capital quality, mentality and social responsibility of business, while *formal institutions* are

the formal rules prevailing in the society: policies, law of property, institutions of shadow economy, and the legal, political and financial institutions (Titarenko & Kirienko, 2014).

The *institutional framework* "encompasses formal rules of the institutional environment and informal rules embedded in ongoing social relations, which interact to shape economic behavior" (Nee, 2005, p. 56). The institutional framework essentially influences which and how organizations come into existence and how they evolve (North, 1992).

The *institutional entrepreneurship* includes all the actions of those players who have the purpose to build or adjust certain institutional frameworks as well as the management of assets and resources to generate different institutions or renovate the existing ones, leading to institutional change (Hung & Whittington, 2011).

Organizations are the players who play the game according to the formal and informal rules supported by the institutional framework (North, 2005). It is important to distinguish institutions, which are the rules of the match, from the organizations, which are the players of the match, in order to avoid confusions of notation (Pinto & Santos, 2013).

Formal Organizations are consciously created structures, within a legitimate frame and with an explicit purpose, and *Informal Organizations* are informal structures that may develop spontaneously, not legally bounded, which are not necessarily characterized by a detailed purpose (Edquist & Johnson, 1997).

The term *triple helix* defines the tripartite relationship between university, industry, and government, in the knowledge society and its importance for innovation and economic development (Ranga & Etzkowitz, 2013). The *quadruple helix* is an extension of this first concept, in which the relations and collaboration among the tree traditional players: university, industry and government, creates innovations mainly based on society needs, becoming civil society the fourth component of the model (Etzkowitz & Leydesdorff, 2000).

Finally, it is very important to make clear distinction over three terms that are often incorrectly used as synonyms when they are not. *Innovation capability or capacity* (IC) is defined as all the aspects that affect an organization's ability to achieve innovations (Saunila, 2016). This capacity or capability in practice can be exploited or not. *Innovation activity* (IA) includes all the technological, scientific, financial, organizational, and commercial activities that are intended or actually lead to the realization and implementation of innovations (OECD, 2005, p. 42). *Innovation performance* (IP) refers to the efficiency and effectiveness of exploiting innovation capability (Saunila, 2014) and according to the Oslo Manual (OECD, 2015) innovation performance referred as business innovation, "is a new or improved product or business process (or combination thereof) that differs significantly from the firm's previous products or business processes and that has been introduced on the market or brought into use by the firm" (OECD/Eurostat, 2018).

Assumptions

As the purpose of this study was to understand the role of institutions within the RIS, there is an implicit assumption that innovation will continue to be important for economic and social development of regions and countries. Another underlying assumption is that certain determinants of coherent and high performing IS exist, and these determinants can provide valuable insights to policy for other RIS (Bartels, Voss, Lederer, & Bachtrog, 2012).

As a survey was used to characterize the sample and assure their engagement in IP, there was a need to assume that people answer truthfully. This assumption can be made based on the rising interest of RIS´s organizations, on having further information about the institutional framework and the impact of the institutions within the systems over the IP, as all organizations involved are promised to have access to the final research report. In fact, the participants of the survey are probably the most interest people on the study to be done in the

most detailed and precise way as it is estimated to have a positive impact on policymaking and institutional entrepreneurship in general.

As the organizations in charge of designing the mechanisms to enhance the RIS of Medellin, took many information from the most recognized IS´s around the world while its construction and consolidation (Amar, 2016), it was assumed that institutions composing the system and their interactions have valuable insights to better understand RISs and that the knowledge generated with the study will be useful not only for the single case unit, but for other regions seeking to improve the institutional frameworks of their RISs, in order to achieve greater levels of IP.

Limitations

Using a particular case searching to understand a bigger reality will always be a limitation when it comes to assume the results applicability to different realities or context, but it is also the best way to start, and focus on small details. There is, of course, many possibilities of refine assumption and propositions in order to develop models in future research after the doctoral thesis is done, and this is in fact interesting and important as it shows the topic potential for future research and publications.

This study was limited to context, he number of subjects interviewed, who agree to participate voluntarily, and those are reasons way there is not possibility of generalizing results or findings.

Finally, the last limitation is time. As the study will be conducted over a certain period, as a cross-sectional design, it will be dependent on conditions occurring during this specific time. This limitation is part of almost any study involving social and economic variables, and can be overcome when considering that there is a need to study the closest reality as a point of start, and then over the knowledge acquire one can continue to update the information, and molded to new conditions and circumstances in the future.

Delimitations

The study was developed by considering the IS of Medellin city, which was developed under a very structured process guided by the ST+I Strategic Plan of Ruta N, a corporation created by the Mayor of Medellin to handle this process and lead the integration of the actors of innovation in the region (Pineda & Scheel, 2010).

The focus of the research was the study of formal and informal institutions existent within the RIS, and their influence over the IP of the adherent formal and informal organizations. Even tough North (1992) mentioned the existence and importance of formal and informal organizations; the studies exploring institutions, organizations and IP, in the last seven years, have placed focus on formal institutions. The inclusion of informal organizations is very important for the present research.

Summary

Innovation economists consider that in knowledge-based economies what largely motivates social and economic growth is innovative capacity (Antonelli, 2003; Johnson, 2008). Innovation, conceptualized as the discovery or creation, development, and application of new knowledge, is a prerequisite for understanding economic growth and is crucial for the sustainability of economies, regions and firms (Garud, Tuertscher, & Van de Ven, 2013). Innovation can be better analyzed considering the system in which is embedded and the dynamical frameworks affecting it, because the IP is not only dependent on the individual performance of players but on the interaction and cooperation among actors and institutions (Johnson, 2008).

On the other hand, new institutional economics as seen by North (1991) seeks to understand social systems from the formal and informal institutions that compose them and claims that every social system plays a series of social, political, and economic activities, all influenced by the institutional framework. After the evaluation of the evidence and data

accessible about RISs, one can observe the increasing significance and application of the knowledge generated by the study, in practical and theoretical terms, reason why it is essential to achieve a better understanding about the particular organizations, institutions and interactions within the RIS.

The aim of this thesis was to analyze the role of institutions for RIS`s organization´s IP, using innovation economics and new institutional economics approaches, in the construction of an appropriate theoretical framework. The research was performed within the Medellin's RIS, as it represents a valuable case in order to extend actual knowledge on RISs and help filling the knowledge gaps identified in the literature review. Finally, the results of this study allowed the generation of useful information that can be valuable for the academic field and for the regions seeking to create and enhance the IP of their RIS´s, and consequently for the economic and social development of the region. This study might facilitate the proposal of appropriate policies that will allow different regions to increase IP levels.

Chapter 2: Literature Review

In the evolutionary approach, when understanding economic development, the attention is placed on the institutions functioning within the social systems, considering the different ways in which these institutions encourage technological innovation and learning processes, and studying the institutional change and its effects over time (Niosi, 2010). Similarly, the vision of IS supports the idea that IP results from the interactive and systemic learning and knowledge, encouraged by institutional mechanisms (Egbetokun, 2013).

The main goal of this chapter is to systematically review the literature about the role of institutions in the innovative performance of the organizations constituting the RIS. This review will present the state of the art on the subject that will allow the identification of the gap in knowledge. The information in this chapter is organized in four sections. In the first section, the process of documentation and the systemic literature review of the material is explained. In the second section, the central concepts to be analyzed in the research are presented, including definitions from seminal authors, and the analysis of the academic literature focused on the institutional framework or on institutional role in innovation systems, is presented. In section three, there is a summary of the findings of the literature review. Finally, the last section includes the conclusion and the identified gap in the knowledge to be attend by the present study.

Documentation

The literature review focused on the period from 2009-2016 inclusive, as a timeframe for the analysis. It also considered some seminal articles that are of relevant for the analysis and useful to understand the evolution of the theory and the core concepts used on the study, as well as some contrasting or critical papers on the matter.

Following the standards of a systematic literature review protocol, the sources for this research were extracted from the EBSCO Discovery Service (EDS). The databases cover by

EDS were: Academic Search Complete, American Doctoral Dissertations, Business Source Complete, Communication Source, Computers & Applied Sciences Complete, eBook Collection (EBSCOhost), EconLit with Full Text, Education Source, Engineering Source, Entrepreneurial Studies Source, Environment Complete, Academic Source Premier, Legal Information Reference Center, Library, Information Science & Technology, MathSciNet EBSCOhost, MEDLINE, MLA Directory of Periodicals, MLA International Bibliography, Textile Technology Complete, Newspaper Source Plus, Small Business Reference Center, SocINDEX, World Politics Review and Regional Business News.

The material was consulted from November 23rd of 2015 to December 5th of 2016, using the next query: TSD 'institution(s)' AND 'innovation system(s)' OR TSD 'institution(s)' AND 'regional innovation system(s)' OR TSD 'institutional' AND 'innovation system(s)' OR TSD 'institutional' AND 'regional innovation system(s)', where TS field is a search based on the topic, title, abstract, and keywords. The first filters included documents from 2009 to 2016, only peer reviewed. The above-mentioned query generated a set of 177 documents and data sheets were elaborated for each document. Three more filters were applied: only academic journals, only written in English, and only full text available; obtaining a number of 43 articles (see Appendix A for details).

Subsequently, the contents of the 43 documents retrieved were briefly examined with the aim of refining the analysis. Certain articles were eliminated because they were related to other disciplines, discussed applications for very specific contexts, or were not related nor relevant to the literature review. After this assessment, the final number of manuscripts was reduced to 40 articles, from 34 academic journals. These 40 articles were categorized, according to the central topic developed, as seen in Table 2. More descriptive analysis of these articles are provided in Appendix A.

Table 2

Recent Articles Classified by Approach and Main Topic Discussed

Approach	Topic	Author	Year
National innovation system	Institutional environment	Kwon, S., & Motohashi, K.	2016
National innovation system		Titarenko, G. B., & Kirienko, D. M.	2014
Sectoral innovation system		Arora, S., Romijn, H. A., & Caniëls, M. C.	2013
Regional innovation system		Renata, P.	2015
Innovation activity		Marqués, P.	2015
Innovation activity		Larsen, K., Gunnarsson-Östling, U., & Westholm, E.	2011
Regional innovation system	Importance of institutions/ institutional environment	Villasana, M., & Chavez, D.	2012
National innovation system		Oluwatobi, S., Efobi, U., Olurinola, I., & Alege, P.	2015
Regional innovation system		Suzuki, M.	2015
Innovation activity		Kumar, V., Mudambi, R., & Gray, S.	2013
Innovation activity		Lee, K. J.	2012
Innovation activity		Cirani, C. B. S., Kono, C. M., dos Santos, A. M., & Cassia, A. R.	2016
Sectoral innovation system		Rosário, P., Peixoto Santa Rita, L., & Pradines de Albuquerque, P.	2013
Innovation activity		Kiparsky, M., Sedlak, D. L., Thompson Jr, B. H., & Truffer, B	2013
Innovation activity		McCaleb, A., & Heiduk, G.	2013
NIS & RIS		Isaksen, A.	2012
NIS & RIS		Egbetokun, A.	2013
Innovation system	The role of formal Institutions	Moodysson, J., & Zukauskaite, E.	2014
Regional innovation system		Qu, Y., Qu, T., & Wu, Y.	2015
Innovation activity		Anderlini, L., Felli, L., Immordino, G., & Riboni, A.	2013
Innovation activity		Rolfstam, M.	2009
Sectoral innovation system	The role of informal Institutions	Della Piana, B., Vecchi, A., & Vivacqua, E.	2015
Innovation activity	Actor´s/organizations interaction	Corral de Zubielqui, G., Jones, J., Seet, P. S., & Lindsay, N.	2015
Regional innovation system		Villasana, M., & Chavez, D.	2012
Innovation activity		Robin, S., & Schubert, T.	2013
Innovation activity		Krishnan, R. T., & Jha, S. K.	2012
Regional innovation system		Caniëls, M. C., & van den Bosch, H.	2011

Table 2

Recent Articles Classified by Approach and Main Topic Discussed (continuation)

Approach	Topic	Author	Year
			2016
National innovation system	Institutions/ institutional environment effect on results	Kwon, S., & Motohashi, K.	
Innovation system		Pinto, H., & Santos Pereira, T.	2013
National innovation system		Zhu, Y., Wittmann, X., & Peng, M. W.	2012
Regional innovation system		Minh, T. T., & Hjortsø, C. N.	2015
Regional innovation system		Kafouros, M., Wang, C., Piperopoulos, P., & Zhang, M.	2015
Technological innovation system		Alexander, E. A.	2012
Regional innovation system		Blažek, J., Žížalová, P., Rumpel, P., Skokan, K., & Chládek, P.	2012
Innovation activity		Cheng, J. L., & Yiu, D.	2016
Innovation activity		Greif, A., Kiesling, L., & Nye, J. V.	2015
National innovation system	Critics	Watkins, A., Papaioannou, T., Mugwagwa, J., & Kale, D (2015)	2015
Sectoral innovation system		Quiroga, M. C., & Martin, D. P. (2016)	2016
Innovation activity		González-López, M. (2011)	2011

These 40 articles beside other seminal and contrasting articles supported the review of key concepts for the research, the theoretical and practical considerations, and the identification of the information gap for future research. Summing up all the material included in the construction of this chapter, this literature review considered 93 relevant articles. It is important to clarify that this literature review limits itself to examine the latest academic research on the topic with the support of some seminal authors and other relevant articles, and it makes no claim that this selection of academic journal articles is complete in reference to all material available in the field.

Innovation.

Schumpeter's (1934) first defined *innovation* as: "(a) an introduction of a new production method, product or its quality, (b) the opening up of a new market or a new source

for raw materials or semi-manufactures, or (c) the creation of a new organizational structure in industry" (p. 66). The most accepted definition nowadays, was provided by the OECD, in which innovation is described as "the implementation of any new or significantly improved product (goods or services), operational processes (methods of production and service of delivery), any new marketing methods (packaging, sales and distribution methods), or new organizational or managerial methods or processes in business practices" (OECD, 2005, p. 46). Joseph Schumpeter (1947) recognized that innovation is determinant for economic and social change, and sought to prove that market power originated in innovation may deliver superior outcomes than the 'invisible hand' of the economy and the price struggles.

Innovation originates in diverse forms and can comprise, but is not limited to, products, services, operations, organizational issues, financial engineering, and marketing strategies (OECD, 2005). According to Ghazinoory et al. (2014), this definition of innovation is so wide that makes the base of innovative community to increase and hinders the possibility of a clear delineation and a more precise measurement of the innovation performance. Innovation in and from developing economies has become a significant component of the global innovative output because it enhances firms' competitiveness to attain success in the global market place (Kumar, Mudambi, & Gray, 2013). Academic literature concerning competitiveness and economic growth recognized the relevance of the regional level and the advantages that an analisys at this level might provide (Coe, Dicken, & Hess, 2008); while remarking the importance of regional interactions in encouraging innovation and economic growth (Asheim & Isaksen, 2002). Furthermore, regions are identified as depositories of tacit and explicit expert knowledge, and arrays of conducts associated to IP, which are important foundations allowing organizations to obtain and sustain competitive advantage (Cooke, 2004). Zhao, Cacciolatti, Lee and Song (2015) analyzed four categories of organizations that exist in national and regional innovation

systems: the government, research institutions, universities and private firms; that is known as the quadruple helix.

Despite firms and organizations remain as essential agents for the traditional model of innovation analysis and policymaking, it has been a while since innovation has left its individual character and started to be understood as a collective process (Pinto & Santos, 2013). Concepts such as industrial districts, technological sectors, clusters, and RISs emphasize on the positive aspects of having a geographical agglomeration of various actors performing activities and achieving better results, than those they could achieve acting individually (Asheim, Boschma, & Cooke, 2006). Consequently, the idea of innovation as an individual decision process independent of the context has been abandoned (Pinto & Santos Pereira, 2013).

Fagerberg and Verspagen (2009) stated that innovation studies have been based under the premise that innovation is determined not only by the interaction of organizations, but also by the context by which they are surrounded. The interaction of the various actors on the system and the activities performed during the innovation process, are all governed by different institutions (Hage & Meeus, 2006; Lundvall, 1992).

New institutional economics theory.

The *new institutional economics* (NIE) theory observes the institutional role in defining the means and forms in which the actors of a social system relate, decreasing the information asymmetry, the transaction costs and guiding the rationality of the players (North, 1992). According to Veblen (1919), *institutions* are "settled habits of thought common to the generality of individuals" (p. 191). North (1992) added, institutions are "the humanly devised constraints that structure human interaction" (p. 3). Scott (1995) presented another variation of the concept of institutions, including three dimensions: the regulative, the normative, and the cognitive. The *cognitive dimension* is founded on principles and

representations of realism approved and supported by values, practices, habits, and widely adopted customs. The *normative dimension* is related to morally governed rules, codes of conduct and norms, which are socially enacted but not legally sanctioned. Finally, the *regulative dimension* embodies the policies, laws and regulations that function as forced instruments, which can be legally endorsed when there is no compliance (Villasana & Chavez, 2012).

North (1991) and Scott (1995) accepted that the major role of institutions in any social system is to decrease instability by creating a steady arrangement to guide social relations. According to Rolfstam (2009), institutions, from the formal laws to the community rituals, subsists as it helps to reduce the ambiguity, providing some beneficial guarantees for its followers. Without institutions, every performed activity would require decision-making and problem solving about what to do. Johnson (1992) explained this idea by providing the following example: "The technical standards about which side of the road one should drive, work as informational devices that make it unnecessary to start life from scratch every day" (p. 25).

Institutional framework and innovation.

Within the NIE theory, an *institutional framework* "encompasses formal rules of the institutional environment and informal rules embedded in ongoing social relations, which interact to shape economic behavior" (Nee, 2005, p. 56), and the institutional framework essentially affects which and how organizations come into existence and how they evolve (North, 1992).

The idea of an institutional framework for innovative development comprises a set of institutions; formal and informal norms and rules (see Table 3), that generate the matrix of economic behavior and represents actions and interactions among different actors, providing as a result, an expected sufficiently stable social structure (Titarenko & Kirienko, 2014).

Table 3

Formal and Informal Institutions and Organizations

	Institutions	Organizations
Formal	Policies	Government Ministries, Departments and Agencies
	Laws	Authorities
	Regulations	Private sector organizations
	Guidelines	Non- governmental organizations
	Formal Codes	External agencies
	Standards	Academic entities
Informal	Customs	Traditional leaders
	Beliefs	Pressure associations
	Norms and Values	Clans
	History	Religious groups
	Practices	Social clubs
	Standards and morality	Community based organizations

Note. Adapted from "Institutions, Institutional Change, and Economic Performance" of North, D. 1992. Cambridge: *Cambridge University Press.*

Organizations have greater opportunities to access and test the knowledge generated in those regions where there exists a stable structure comprising an assembly of specialized research institutes, universities, technology transfer agencies, and an institutional environment that encourages innovation (Cooke, 2002; Zhao, Cacciolatti, Lee, & Song, 2015; Hekkert, Suurs, Negro, Kuhlmann, & Smits, 2007).

Oluwatobi, Efobi, Olurinola, and Alege (2015) stated that when there is a favorable institutional framework, innovation flourishes; but if the institutional framework is unfavorable, innovation diminishes. The dynamics of the economic system can support the development and growth when they provide a favorable institutional environment that facilitates the innovative performance and the adopting or mastering new technologies (Nelson, 2008). Additionally, following North's perspective, numerous papers state that for innovation systems and innovative performance institutions matter (Kwon & Motohashi, 2016; Li, 2015; McCaleb & Heiduk, 2013; Minh & Hjortsø, 2015; Moodysson, & Zukauskaite, 2014).

On the other hand, the economics of innovation, also referred as *innovation economics* (IE) for some authors (Atkinson & Ezell, 2012; Korres, 2012; Spulber, 2013), is defined as "the body of economic theory that contends a priori that economic development is the result of appropriated knowledge, innovation and entrepreneurship operating within an institutional environment of systems of innovation" (Courvisanos & Mackenzie, 2014, p. 41). Within the IE theory, academics and authors have remarked the importance of localization and institutions for IP (Pouder & St. John, 1996; Whittington, Owen-Smith, & Powell, 2009). Institutions encourage organizations to develop specific competitive capabilities more effectively in certain industries and that these capabilities condition the patterns of specialization and economic performance (Pinto & Santos, 2013). "Without institutions, a social system would not be able to accumulate knowledge, or enable communication; and would therefore be unable to sustain innovation" (Rolfstam, 2009, p. 25).

Following North´s position, Titarenko and Kirienko (2014) defined *informal institutions* for innovation as the social standards in the behavior of actors concern morality, level of civic culture, economic intelligence, human capital quality, mentality and social responsibility of business, while *formal institutions* were defined as the legal confirmation of formal rules prevailing in the society: policies, law of property, institutions of shadow economy, and the legal, political and financial institutions.

Oluwatobi, Oluyomi, Olurinola, and Alege (2016) studied the role of formal institutions in the innovation activity on Sub-Saharan Africa, and found that the most relevant ones within that context were control of corruption, government effectiveness and regulatory quality. Also emphasizing on formal institutions, Quiroga and Martin (2016) highlighted the role of the institutional framework as it can favor entrepreneurship behaviors and the practices of the enterprises regarding innovation, as well as play a role in structuring innovative clusters. It is important to bear in mind that in the case of formal institutions, "the

term 'policy' should be understood in a broader sense, embracing activities carried out, not only by the public sector, but also by actors from all three spheres of the triple helix constellation" (Borrás & Tsagdis, 2008, p. 166). The concept of the *triple helix* was coined in the 1990's by Etzkowitz (1993), as a way to understand the growing importance of the multilateral interaction between government, university, and industry for IP and economic progress, in comparison with the traditional perspective of industry-government collaboration common in the industrial society (Ranga & Etzkowitz, 2013). The term *quadruple helix* is an extension of the fist concept, which enlarges with one more helix the IS, being the fourth helix the civil society (Etzkowitz & Leydesdorff, 2000), and pointing that the triple helix model is not satisfactory to understand longstanding innovation progress and that there is a need to consider the relevance of citizens and civic associations. As The European Commission (2010) said, in the knowledge-based economy collaboration among all parties involved is crucial, including the citizens that act as social partners, which participate in the creation, diffusion and use of innovations, gaining an important function within the IS. The whole society is involved in innovation, while the government might contribute to organizational innovation by offering economic incentives and favorable policy environment, social agents impulse innovation by the demand of improved, novel and better products and services (Afonso, Monteiro, & Thompson, 2012).

Caniëls and van den Bosch (2011) explained that the regional innovation system that is available at one point in time has to be taken into account as an important factor determining whether knowledge interactions between university, industry, and government, will be successful or not. Nonetheless, it is necessary to consider that IS and institutions are not static (Carlsson et al., 2002) as institutions and organizations co-evolve (Hage & Meeus, 2006). The system will always confront *institutional entrepreneurship*, which includes all the actions of players that have the purpose to create or modify certain institutions and

frameworks as well as the efforts to find the resources needed to accomplish that task and achieve favorable institutional change (Hung &Whittington, 2011).

Innovation systems.

The *innovation system* (IS) concept is broadly accepted by academic and policy agents, with the aim of explaining the way in which the collaboration and cooperation among different parties, related to a geographical location or technological sector, might enable the innovation activity and performance (Corral de Zubielqui, Jones, Seet, & Lindsay, 2015; Moodysson & Zukauskaite, 2014; Pinto & Santos, 2013; Sotarauta & Mustikkamäki, 2015). Since late 90's different notions and approaches to characterize the systemic viewpoint on IP were developed and the literature on IS expanded rapidly (Cooke, Uranga & Etxebarria, 1997; Freeman, 2002). Initially, the concept of IS was constructed with an emphasis on the issues concerning organizations (Cooke, et al., 1997) and later the concept was deepen in institutional issues (Tödtling, 1999). Different definitions of ISs are presented in Table 4, and it is remarkable that all of the authors include the institutional dimension on their definitions.

Table 4

Definitions of Innovation System by Different Authors

Freeman	"The Network of institutions in the public and private sectors whose activities and interactions initiate, modify and diffuse new technologies"
Carlsson	"Dynamic network of agents interacting in a specific economic/industrial area under a particular institutional infrastructure and involved in the generation, diffusion, and utilization of technology"
Lundvall	"All parts and aspects of the economic structure and the institutional setup affecting learning as well as searching and exploring"
Nelson	"Set of institutions whose interactions determine the innovative performance [...] of nation firms"
Edquist	"All important economic, social, political, organizational, and other factors that influence the development, diffusion, and use of innovations"
Hekkert et al	"A heuristic attempt, developed to analyze all societal subsystems, actors, and institutions contributing in one way other, directly or indirectly, intentionally or not, to the emergence or production of innovation"

Note. Adapted from "Assessing the functionality of an innovation system" of Rickne, A. 2001. *Goteborg, Chalmers University of Technology.*

The literature on ISs can be classified along three lines: studies that explain how ISs emerge and evolve; studies that examine how ISs condition economic development; and studies that identify what makes ISs strong or favorable (Egbetokun, 2013). Within the extent of studies that examined how ISs condition economic development, Hekkert et al. (2007) defined that the role of ISs includes organizational performance, knowledge creation and diffusion, research and development, market materialization and assurance of legality.

The entrepreneurial activities related to organizational performance refer to actions that lead to IP generating new business opportunities and gains for the firm. *Knowledge development* includes learning by doing and learning by searching. *Knowledge diffusion* includes the transmission of knowledge through collaboration, were learning can be achieved by doing, by using and by interacting. The research function may be based on real needs and demands. Finally, the market development includes the efforts to prepare people to adopt and use new technologies and improved products and services resultant from innovation process (Hekkert et al., 2007).

Because of the different applications of the concept of innovation system, more specific concepts were developed to improve IS theory, and theorist considered that innovation activity was worth to be examined "at other levels of the economy than the nation state" (Lundvall, 2008, p. 100). Since the notion of NIS that appears for the first time in 1985 thanks to Lundvall, the efforts to apply the concept to a smaller units of analisys, as the regional level, has been very accepted (Breschi, 1995). Among these conceptual perspectives, the most important are the technological innovation system (TIS), the sectoral systems of innovation (SSI), and the regional innovation system (RIS). The TIS vision was developed by Carlsson and Stankiewicz in 1991, focusing on the relation among a set of actors and institutions related to a specific technology, which can be used in multiple industries or sector or with different ends (Bergek et al., 2008). The SSI vision established by Breschi and

Malerba (1997) highlighted the importance to examine IP in the context of a given economic sector that involves different types of agents who cooperate and interact towards creation, sales and distribution of sectorial related products and services. Finally, the RIS concept proposed by Cooke et al. (1997) and Asheim and Isaksen (1997), proposes the localized analisys of IP within the regional context, shed better light on the dynamics and interactions, including knowledge generation, exchange and accumulation, where locally bounded players and institutions participate, as a result of the personal interaction and face-to-face communication (Cooke, 2002). "Economic actors clustered in close geographical proximity tend to innovate more and to benefit more from knowledge spillovers than those working in remote locations" (Rodríguez-Pose & Comptour, 2013, p. 212). It is important to understand that there is an interplay between national, regional and sectoral systems (Malerba & Nelson, 2011).

In view of the different approaches to the IS, the national vision of the concept has dominated the ISs academic texts, with a share of about 50%, during the past 20 years; while RIS covered near 25% of literature, 19% is related to technological systems, and finally, the sectoral systems account for the 6% (Carlsson, 2006). However, as it is possible to observe the literature on RISs is growing in importance and the quantity of papers on the subject has almost double in the last five years (see Appendix B).

Considering all the different views of ISs, the RIS analisys is the most compatible with the traditional versions of the NIS, as both approaches underline the fact that there are learning process and knowledge generation locally bounded, as innovation is closely affected by proximity, interaction and collaboration (Asheim & Coenen, 2005). Additionally it is important to consider that in relation to the definition of NIS, Cooke et al. (1997) remarked the ambiguity when conceptualizing the national notion; as a consequence the current approaches and recent authors, especially in Europe but also in other robust economies,

suggest that the NIS is mora like the set of the different RIS that operate within (Asheim & Coenen, 2005).

Regional innovation systems.

The concept of RIS was introduced by Cooke, Uranga, and Etxebarria in 1997, and it is defined as "a localized network of actors and institutions in the public and private sectors whose activities and interactions generate, import, modify and diffuse new technologies within and outside the region" (Iammarino, 2006, p. 499). The concept of RIS also includes the institutions helping to increase innovation, and all the mechanism supporting innovative activity within the economic structure in a particular region (Asheim & Coenen, 2005). From a general perspective, the research in the field of RIS can be characterized using the following dimensions or levels: (a) the organizational approach, , which focuses on activities and matters related to organizational levels and organizational interaction among all types of firms collaborating in the RIS (Muller & Zenker, 2001; Christopherson & Clark, 2007); (b) the institutional approach, where the main subject of interest are the institutions and the institutional structure affecting all player`s performance (Asheim, Smith, & Oughton, 2011; Asheim, Moodysson & Tödtling, 2011); (c) the capabilities approach, in which differences in regional performance obey to dissimilar intrinsic resources and capacities for each region (Zhao, Cacciolatti, Lee & Song, 2015; Lau & Lo, 2015); (d) the national approach, that seeks to understand the NISs by analyzing the various RISs that operate within (Carrincazeaux & Gaschet, 2015; Lengyel & Leydesdorff, 2011; Sun & Liu, 2010); and (e) the assessment perspective, that considers the measurement factor as crucial to follow up RIS`s performance, and the appropriate metrics to compare different RISs (Zabala, Jimenez, & Gutierrez, 2005; Zabala-Iturriagagoitia, Jiménez-Sáez, Castro-Martínez, & Gutiérrez-Gracia, 2007; Leydesdorff & Fritsch, 2006).

According to Arora, Romijn, and Caniëls (2013), RISs are constituted by organizational models and institutional framework. As said by the authors, *organizational models* include "the heterogeneity of actors and the ways in which the actors form networks in an innovation system;" while institutional framework "refers to the group of formal and informal institutions assembled, which directly govern the innovative activities in specific organizational models" (p. 573).

Innovation systems and institutions in developing countries.

Malerba (2007) stated that the innovative activity might differ between nations due to the specific institutional factors related to NISs or to the presence of an industry with a peculiar history; as there is no similar distribution of institutions, a variety of profiles of productive and economic performance might emerge across nations (Pinto & Santos, 2013). The concept of IS delivers a guide useful for developing countries, when improving performance and catching up with more developed economies (Watkins, Papaioannou, Mugwagwa, & Kale, 2015), and according to Edquist (2001) the types of organizations and institutions that are appropriate to achieve innovation goals for developing countries are different from those for developed countries, because developing countries are progressing slowly in relation to innovations. In the developing countries the focus should be on an intelligent specialization, prioritizing industries or industrial sectors in which the crucial variables, such as human capital, need to be reinforced (Isaksen, 2012; Lundvall et al., 2011). According to Isaksen (2012), efforts should focus on technology-intensive sectors, and early-stage enterprises, for small entrepreneurs who need to grow and strengthen their potential niches.

Finally, evidence from emerging markets and economies, such as Singapore and South Korea, indicates that growth driven by innovation might help developing economies to increase their rates of growth, their social and economic performance; for this to happen the

institutional framework needs to be solid and steady (Oluwatobi, Efobi, Olurinola, & Alege, 2015).

Institutional effects on innovation performance.

The concept of *innovation performance* (IP) includes all the results related to the implementation an exploitation of innovations (OECD, 2005). The IP is considered one of the most critical aspects of prosperity and growth, contributing directly by improving turnover and profitability, or indirectly by increasing employment (OECD, 2011). Edquist and Johnson (1997) suggested that institutions could function in three ways to foster the IP:

First, institutions can serve to reduce uncertainty by providing information, also through informal means, such as networking among practitioners and industry conferences. Second, institutions can actively manage conflicts and foster cooperation, such as when stakeholder processes allow the communities to engage with the development of more durable solutions that consider multiple interests. Third, institutions can provide incentives for innovation. For example, patent laws generally protect new intellectual property such that entrepreneurs can profit from taking risk on technology development (p. 41).

As different types of institutions affect the IP of the RIS (Arora, Romijn, & Caniëls, 2013), the discussion will now focus on institutions classified as formal and informal (North, 1991), based on the previous definitions provided in this chapter. Within an RIS, the creation of regional innovation policy networks should be supported, considering the local and the global level, as well as the promotion of links of various types between the university and the industry (Cooke et al., 1997). In the same line, Oughton, Landabaso, and Morgan (2002) identified three main objectives for a regional innovation policy (which is a formal institution) that covers multifaceted aspects of innovation, stating that it should: "(1) facilitate coherence and collaboration among actors, (2) identify and express the needs and demands of

the actors, and (3) coordinate strategies for approaching these needs and demands" (p. 110).

As stated by Moodysson and Zukauskaite (2014), the formal institutions are to cover the system in a holistic manner, instead of focusing on only a few organizations, and this apply specially for the case of institutions seeking collaboration and coordination in the implementations of strategies to address the needs and demands of the participating actors and organizations.

Much work has been done about formal institutions operating at the core of innovation systems, but according to North (2005), informal institutions, such as convention codes of behavior and culture, which do not necessarily laid down in writing, tend to be more persistent than formal rules. As said by Moodysson and Zukauskaite (2014), the crescent importance of informal institutions for the RISs is seen on the increasing implementation of regional plans and strategies that stimulate the innovation culture, the mobility and the cooperation between industry and academia, instead of using more firm-oriented laws and programs for R&D, and subsidies or directed provisions of venture capital. In the same line, Kiparsky, Sedlak, Thompson, and Truffer (2013) indicated that culture plays an important role in the ability to innovate, and specifically risk aversion, as an aspect of culture, is a central facet, but despite the crucial role of acknowledge the informal institutions, limited research has examined innovation across cultures (Della Piana, Vecchi, & Vivacqua, 2015).

The need of coordination between the formal and informal institutions that conform the institutional framework raises a challenge, since the laws, policies and rules, in essence, are created and managed by different players at different regional and national levels, and with different ways to influence the system and its mechanisms (Moodysson & Zukauskaite, 2014). Coordination efforts include the consideration of aspects like the rigidity or flexibility of the RIS, as according to Anderlini, Felli, Immordino, and Riboni (2013), a *rigid system* exists when the law is set before the technological innovation and a *flexible system* exits

when the law is set after observing the new technology. When the development of technology is incipient, the flexible system is preferable, since legal and systemically change are needed, while in the early and middle stages of technological development, a rigid system is preferable, for address the severe risks inherent to the initial operation and lack of commitment (Anderlini et al., 2013).

On the other hand, according to Niosi (2002) inefficiencies in the institutional framework, as well as in individual institutions of an innovation system, may affect the IP, and general inefficiencies are based mainly on four factors: inadequate system rules, lack of or limited number of key organizations, weak coordination among units and lack of information flows. The author explained the four factors as follows. Inadequate system rules refer to incomplete intellectual property legislation, for example copyright or patent protection, as well as inadequate laws on corporate disclosure. Lack of key organizations, as for example research universities, government laboratories or technological observatories. Weak coordination among actors could happen because a lack of public incentives for organizations to cooperate with industry or with government. Finally, the deficiencies on information flow may happen between firms and technological observatories or public laboratories because of poor mechanisms and platforms to interact in a confident way (Niosi, 2002),

Empirical studies on institutions and innovation systems.

Several studies were found analyzing the impact of institutions on regional development and network creation. This focus on a the various types of institutions influencing actors' collaboration and IP is commonly observed in the recent literature about IS, and is presented as follows, in chronological order.

Rolfstam (2009), through an analysis of secondary data, considered three study cases in order to analyze the role of public procurement in innovation and clearly identified

government purchases and procurement as an innovation tool that can be managed trough

policy. Evidence showed the public procurement was moving closer and closer towards the

center of EU innovation policy. Rolfstam (2009) also concluded that it is necessary to fully

understand the institutional interplay involved, this means to consider the exogenous

institutions, as well as the endogenous institutions.

European countries have been attracting the most attention of researchers on the topic,

but research on Asian countries and regions is considerable. For instance, Hung and

Whittington (2011) carried out a study in the Taiwanese IT sector, analyzing how

institutional entrepreneurship affects the NIS. The results of the research suggested that

institutional agents who skillfully use a combination of strategies to structure, aggregate and

create networks are more likely to create new forms of organization within their NIS. The

study also found that institutions were changing from a recovery strategy to a more proactive

one, and that business network strategies were shifting from the main import of technologies,

ideas and capacities to a greater importance on exporting outcomes to the rest of the NIS.

Alexander (2012), adopted the institutional lens of Scott (1995), and examined the

effect of different levels of cultural-cognitive, normative, and legal institutions on the IP

levels. Key findings of the study indicated that normative and cultural-cognitive institutions

do affect the performance outcomes, as they provide supporting mechanisms to control the

dominant cultural-cognitive frame of uncertainty avoidance and the organizational risk in

alliances and hence contribute to enhance the IP. The presence of formal institutions to

enforce contracts and highly formalized legal processes is associated with higher levels of IP

in contexts where uncertainty is avoided (cognitive-cultural institution) and where

individualism (normative institution) predominates, while the opposite effect is observed in

conditions with low uncertainty avoidance and tendency to collectivism (Alexander, 2012).

For the case of the country of China, Zhu, Wittmann, and Peng (2012) identified five key institution-based barriers to innovation for small and medium enterprises via semi-structured: (a) competition fairness, (b) access to financing, (c) laws and regulations, (d) tax burden, and (e) support systems. These findings enhanced the knowledge about the institution-based view of entrepreneurship, by shedding light on how institutions are not always useful and can represent barriers affecting negatively innovation in small and medium enterprises.

In the vision of Lee (2012) the theory of coevolution of copyright institutions and technological innovations, helps to understand how the business of mobile music in Japan and Korea has developed. The findings of his research suggested that the existence of divergent national institutions in terms of copyright, led to contrasting industrial changes and different types of interactions between technologies and institutions in the two countries.

Krishnan and Jha (2012) investigated the nature of collaboration between industry and academia in the Indian automotive sector, and in their conclusions stated that innovation and cooperation programs can be justified mainly from a long-term perspective, in order to build competence in both industry and academia, and should enable better understanding of each other's' capabilities to increase the probability of improved cooperation without state intervention in the future. Chen, Egbetokun and Chen (2015) said that relying heavily on intermediaries to mediate the relationship between actors could diminish the effect of dynamics, suggesting that it is better to stimulate the direct relationship between research centers and companies, creating more efficient and effective dynamics of innovation.

In the same year, Villasana and Chavez (2012) applied an empirical study using the grounded theory approach to addresses the impacts that the institutional framework may have had on university-industry interactions and academic entrepreneurship in Nuevo Leon, Mexico. Their findings suggested that university researchers seeking to engage in

entrepreneurial activity and projects with industry face organizational challenges that surpass their motivation, so the local institutional framework must guarantee incentives not only for private, but also for academic entrepreneurship.

Blind (2012) performed a study based on a panel data from 1998 to 2004, of 21 OECD countries to identify the types of institutions that affect innovation and examine the linkage between these institutions and innovation. The author found various types of institutions to be relevant, including competition and cooperation legislation, pricing policies, production laws, environmental legislation, intellectual property rights, and legal structure. The results of his study concluded that institutional framework significantly affect the dynamics of IP in countries members of OECD, and specially, the legal and regulatory framework.

Finally, Blažek et al. (2012) developed a comparative in-depth analysis of three different outlooks towards innovation assistance in three areas of the Czech Republic, which were Prague, South Moravia, and the old industrial region of Moravia-Silesia. The results reflected differences in both formal and informal institutions in the three regions. In Prague an obvious advance was seen, in terms of the operation of the innovation strategy, and this region is characterized by a great capacity for knowledge creation both in the academic and business areas, together with a key attitude of the staff and of the intermediary institutions, as well as a constant political and legal support that backs regional decisions.

It is interesting to notice that during the 2013 and 2014, the empirical research on institutions and innovation activity expanded in many different countries and regions including East Asia, Jatropha (Tanzania), United States (U.S.), Germany, France, Alagoas (Brazil), Ukraine, and South Australia. For instance, in East Asia, McCaleb, and Heiduk (2013) shed light on the question of whether the traditional institutions shaping the Asian developmental model were weakening because of globalization, or instead, adapting to it.

The authors found that production networks are to an increasing degree institutionalized bridges that connect global and local firms, and the authors concluded that the institutionalization and instauration of new knowledge need more than regulation, as the law cannot enact the societal acceptance of innovation, being a private and not a public act.

In Tanzania, Arora, Romijn, and Caniëls (2013) analyzed the growth of Jatropha biofuel sector and considered organizational models and institutional frameworks from the SSI perspective. The institutional framework analyzed for the case was amassed through postcolonial Tanzania's story which influenced the kind of institutions of Jatropha and the manifestations of specific institutions including the ideas of elites in political roles which relegated low income peoples' necessities, the absence of faith among state and non-state actors and the legislative and constitutional decrees.

In relation to institutional entrepreneurship, Larsen, Gunnarsson-Östling, and Westholm (2011) in their article expressed the need to start policy transformations in designing low-carbon societies in face of the climate change challenge and the importance of local and global innovation processes and institutional change, targeting sustainable urban futures.

Kiparsky et al. (2013) analyzed the innovation deficit in relation to urban water service in the U.S. and the importance of counting on a unified frame about organizations, institutions, and technology. Conclusions of their study indicated that due to the practical and institutional risks related to the management of urban water, and the need to include in the institutional framework the concepts related to innovation, recognizing this may not be easy, as by essence innovation in volatile and difficult to foresight.

In France and Germany, Robin and Schubert (2013) collected information using the community innovation survey (CIS) from 2004 and 2008, to evaluate the influence of firms' and government research centers collaboration on the IP, materialized as product or process

innovations. The study found that firms' cooperation with public research increases product innovation, but has no effect on organizational and operational process innovation, but it has no implications for operational and organizational innovation, observing that these two depend on the opening of companies. This research concludes that it is not always appropriate to carry out expensive research collaborations between government and firms, given that these agreements often turn out to be costly and do not always have positive effects on all types of innovation.

In Alagoas, Brazil, the statistical tests of Rosário, Peixoto, and Pradines (2013), confirmed that there is an association between the three dimensions: organizations, institutions and new technologies, and that much of the technical and technological development advancement came from government-industry partnerships and interaction between universities and research centers.

The analysis of Titarenko and Kirienko (2014) about the generation and development of Ukraine's NIS concluded that the institutional framework structure is an important condition for increasing the level of competitiveness and the importance of the development of those formal institutions that provide innovative climate and competitiveness. The authors concluded that the institutionalization of innovation means to create favorable environment for innovation in the form of the implementation of relevant rules and regulations through the mechanisms of economic and legal regulatory activities.

In the year 2015, abundant articles exploring institutions, IS, and IP were published, and the cases studying Asian countries and regions dominated the literature. Yet, other countries and regions were also considered by researchers, such as Africa, South Australia, Vietnam, Portugal, and Tatarstan. It is noticeable that the number of articles published in that year is the highest since 2009 to date. In South Australia, Corral de Zubielqui, Jones, Seet, and Lindsay (2015) studied the crucial importance of the networks and interaction between

universities and industry to make the RIS work more effectively. Conclusions of this study highlighted the need of better policy and better resources devoted to help universities cultivate linkages and get closer to the industry. Similarly, for the Vietnamese case, Minh and Hjortsø (2015) explored how the institutional framework and organizations' interaction in the Vietnamese agribusiness and research findings suggested that even with the presence of formal aid schemes to support the PI, these governmental mechanisms were not well developed and implemented by the designated intermediary agents. A wider acceptance of the normative and cognitive institutions was seen, more than of the regulatory ones, observing that the players tended to form networks and teams more based on their strong ties than on the formal mechanisms available, which limits collaboration and knowledge flows, restraining its effects to only a few organizations.

Similar to Hung and Whittington (2011), Sotarauta and Mustikkamäki (2015) also focused on institutional entrepreneurship. Sotarauta and Mustikkamäki (2015) suggested that the process of establishing new mechanisms in the SI has to be analyzed in the long term because the institutional change is closely related to the agents that intervene, and these agents exercise a high relational power. According to the authors, the power of institutional agents is given by their convincing arguments and with the notoriety of their knowledge and not vice versa. For these reasons, the investigation and questions to the future should focus on the skill, tactics and strategies exercised by the various actors in the process of institutional change and not only those who have or exercise the institutional power.

Oluwatobi, Efobi, Olurinola and Alege (2015) examined the effects of institutional development on innovation on a sample of 40 African countries. The analysis performed revealed the positive impact of the institutional dispositions in the intellectual property rights and innovation, presenting a greater effect in the levels of IP the aspects of institutional quality and governmental effectiveness. In addition, the findings suggested that IP levels

could be positively changed in the country, if measures to reduce corruption are adopted, in order to increase confidence levels in the public sector, and if institutional quality is improved.

Similar to the research developed by Kiparsky et al. (2013) about barriers to IP in urban water institutions, Suzuki's (2015) study identified barriers in clean energy technology innovation and development, and defined the importance of international institutions for overcoming these barriers. Based on findings, the author proposed that the four areas of focus or goals for international institutions should include: (a) increasing R&D cooperation at the innovation stage, (b) the facilitation of intellectual property rights, (c) supporting finance and investment, and (d) improving the enabling environment at diffusion stages.

Kafouros, Wang, Piperopoulos and Zhang (2015) studied 31 provinces in China to understand how the interaction between universities and research centers affects the ability to generate and develop innovations in organizations operating in Chinese emerging markets, as well as the capacity to generate patents and intellectual property. What findings of the research indicated that it is not correct to develop a rigid institutional framework to apply to a whole territory at the national level, since the needs, and therefore the institutions, develop in a different way in diverse regions. Kafouros et al. (2015) found that three mechanisms could be used from the point of view of government regulation, to support the effectiveness of the interaction and the results of IP. First, there is the correct regulation of intellectual property rights and the fair application of the norm in different cases. Second, the creation and execution of policies is required not only at the national level but also at the international level to facilitate interaction and cooperation with other regions and with other countries. Finally, the improvement of the research systems and the creation of schemes that allow a better development and use of knowledge and human talent.

Krishnan and Jha (2012) and Villasana and Chavez (2012) also focused their studies on the importance of industry-university collaboration and the impact of institutions on this relation, but they performed the analysis in India and Mexico, respectively. Results in the three studies present many similarities.

Along with Kafouros et al. (2015), Qu, Qu, and Wu (2017) examined the importance of formal institutions at a regional level, in the IP and IA of Chinese organizations, also concluding that there are differences in the institutional development among different regions as inherent resources are dissimilar (e.g. risks, cost, materials, capacities, geographical advantages), and the creation and usage of this resources is also influenced by the institutional framework.

For the case of the RIS in Tatarstan, Renata (2015) identified that for supporting the regional innovation potential there are seven key institutions, which are: (a) institution of property, (b) institution of judicial system, (c) institution of corporate management, (d) institution of local government, (e) institution of regional regulation of innovation activities, (f) institution of government-industry association for innovative activities, and (g) the institution of patent protection of R&D results.

Della Piana, Vecchi, and Vivacqua (2015) performed an explorative study in order to compare the innovation of firms across 16 countries in Europe, and findings suggested that the most innovative clusters are the Nordic Cluster, the Anglo Cluster, and the Germanic Cluster. Results also supported the proposition that innovation performance is indeed "culture-specific" and informal institutions make the difference. This study, along with studies of Alexander (2012), and Corral de Zubielqui, Jones, Seet, and Lindsay (2015), were the only ones to place informal institutions, specifically cognitive and cultural dimensions at the center of the analysis.

In the same year, Marques (2015) analyzed the factors that had conditioned the development of the economy as a whole in Portugal, and how the imbalance results in an absorption of resources for few well-connected organizations and to an environment that does not encourage wide learning and innovation in the economy. Results of this study present some similarities with the study by Arora, Romijn, and Caniëls (2013), on the case of Jatropha, Tanzania.

More recently, in 2016, four articles were published in relation to institutions and innovation, while two of them were focused on Latin American cases. Asian countries continue to be of high interest to academics studying the topic. These articles are relevant for the purpose of the present study.

Kwon and Motohashis's (2016) analysis revealed that the Japan's NIS presented advantages in those types of industries where the necessities and demands of consumers change more quickly, supporting the acceptance of incremental innovation, while in contrast, the United States NIS, where demands seek a greater impact, the industry benefits mostly from radical innovation. The article shows how the behavior of U.S.'s firms is a reflection of the institutional environment and liberal orientation at the national level, while the behavior observed in Japanese firms reflects an institutional environment that emphasizes a strong inertia.

In China, Cheng, and Yiu (2016) used case analysis to understand the institutional changes that would be needed in order for Chinese firms to compete successfully in the innovation driven global economy. According to the conclusions, the necessary changes included the development and support of informal institutions to achieve the adoption of formal institutions, the strengthening of patent and copyright protection, the reform of the educational system with emphasis on critical thinking and creativity, and the change in the policies to encourage a more fluid relationship between the government and the industry. The

last finding also matches with the conclusions made by Arora, Romijn and Caniëls (2013) in the case of Jatropha, Tanzania, and the conclusions of Marques (2015) for the case of Portugal.

In Bolivia, Quiroga and Martin (2016) findings highlighted that the disparity of the existent formal institutions in front of the real requirements, added to the traps of innovation produced by the socio-technological regimes, are constituted as barriers to the creation of invocation cycles. Hence the importance of finding mechanisms through which there is an integration between the existent formal institutions and the specific contexts of the affected organizations.

Also in Latin America, specifically in Brazil, Cirani, Kono, dos Santos, and Cassia (2016), examined the most relevant formal institutions for the innovation in Brazil and the conclusions were that, although the organizations included in the sample were interested in using the existent mechanisms, they face strong difficulties in the application given the complexity in the processes, the bureaucracy, the slowness in the revision of the projects, and the legal insecurity that causes issues of trust. The latter difficulty identified is related to what happened in the case of Jatropha biofuel sector in Tanzania (Arora, Romijn, & Caniëls, 2013).

The main conclusion of the study, as for the case of Bolivia (Quiroga & Martin, 2016), was that formal institutions for innovation support in Brazil, including funding agencies, should be better aligned with organizational strategies and needs, and should articulate the instruments offered with organizational structures and process.

Contrasting authors.

Pinto and Santos (2013), stated that the concept of IS encompasses several dilemmas, being the most noticeable: (a) the difficulties in addressing the pertinence of national or any other geographical scale to understand innovation and economic performances in the context

of globalization, (b) the difficulty to define the constitutive elements of a IS, and (c) the obstacles in the delimitation of IP and assessment of results.

In relation to institutions, Watkins, Papaioannou, Mugwagwa, and Kale (2015) reports differ from all of the studies previously revised, which place the institutional framework at the core of the IS. The authors revised the NIS literature chronologically, and concluded that a change in focus has reduced to some extent the relevance placed on formal institutions, especially on those institutions managed by governments and constituted as official frameworks from public administration. The authors found that other types of intermediaries, such as industrial associations, are important for understanding the system dynamics, and how institutional capacity advance especially in developing countries. Watkins et al. (2015) observed that these findings are due to the lack of governance present in this type of countries where there is more inequality, insecurity and less effective regulatory frameworks.

González-López (2011) studied how the institutions affected the level of innovation in coastal fishing activities in Galicia, Spain. The author said that although most of the literature supported the argument of institutional benefit from the greater stability and knowledge flow that they provide to the system, there are cases in which institutions negatively affect change and innovation, especially when the regulatory framework does not evolve at the pace of considerable or radical innovations. In the same line, Hung and Whittington (2011) affirmed that in order to endure, organizations might have to innovate internally, even in contrary way to the national policies and IS's logics.

After revising the articles selected for the literature review it is possible to observe how, in the last 5 years, the research about institutions and their impact on the RIS's IP has been focused mainly of qualitative analysis from both theoretical and empirical perspectives. Empirical research to explore the interaction of institutions with organization's innovative performance within an RIS, has been done in different places as South Australia, North-west

region of Brazil, Nuevo Leon (Mexico), Jatropha (Tanzania), Tampere (Finland), Tatarstan (Russia), Prague (Czech Republic), South Moravia (Czech Republic), Alagoas (Brazil), Galicia (Spain) and 31 provinces of China. These studies provide valuable knowledge to continue the study of the topic, expanding it to other regions, and deepen the analysis of institutional role on IP within the RISs.

As said, most of the research made about the topic have used a qualitative approach, and only three papers matching the designed criteria were found to measure institutions quantitatively. The studies that used quantitative analysis are those of Alexander (2012), Oluwatobi, Efobi, Olurinola, and Alege (2015), and Rosário, Peixoto, and Pradines (2013), the first used the institutional approach of Scott (1995) and the last two followed North´s (1995) perspective. In all three cases, the authors have used isolated measurements rather than a formal measurement instrument or questionnaire. None of this authors have applied validity and reliability tests to the measurement scales and in the case of Rosário et al. (2013), the authors only measured the perceive of importance of the institutions, reason why their conclusions could be distorting from reality, as they are only based on interviewed subjective perceptions and self-report.

In conclusion, the lack of validity test on the instruments and difficulties in sampling process made none of these three researches apt for generalization at any level. According to Boudreau and Lakhani (2016) the reason for the short number of quantitative articles on the subject, is that these purposes of studying the innovation, and the operation of institutions in the innovation process, face a great complexity, since several variables can play alternated roles, and it is not easy to study the effect of certain mechanisms when trying to understand the true nature of the process, preventing the achievement of appropriate results. The present study intends to be the first step in the definition of a more appropriate analysis framework

for RISs from the institutional perspective, which possibly allows for the future development of valid and reliable measurement tools.

Although some authors have asserted that research on the role of subnational institutions and regional statistics of factors facilitating or restricting interactions and collaborations between actors and organizations has been little (Kafouros, Wang, Piperopoulos, & Zhang, 2015), the literature review indicated the opposite to be true. It can be observed that various studies have been done in the last 6 years, in which the analysis is focused precisely on understand the effect of this institutional frameworks on the interactions between actors and organizations (Arora, Romijn, & Caniëls, 2013; Blažek et al., 2012; Corral de Zubielqui, Jones, Seet, & Lindsay, 2015; Renata, 2015; Rosário, Peixoto, & Pradines 2013; Sotarauta & Mustikkamäki, 2015; Villasana & Chavez, 2012), and the number of articles matching all the criteria since 2009 has been increasing (see Table 5).

Table 5

Number of Articles about Institutions and RIS per Year since 2009

Year	No. of articles	%
2016	5	13
2015	13	33
2014	3	8
2013	8	20
2012	6	15
2011	4	10
2010	0	0
2009	1	3
Total	40	100

Summary

Even tough Europe keeps being the focus of IS studies, the amount of research in Asian countries and regions is noticeable. It is also important to recognize the appearance of African countries and regions on the studies, while the attention towards Latin American

countries is in its beginnings. There are some final interesting findings from the systematic literature review. Only four papers, those from Zhu, Wittmann and Peng, (2012), Kiparsky (2013), Robin and Schubert, (2013) and Suzuki (2015), accounted for more than 50% of the citations on the topic.

With 39 articles from 34 journals, there is no concentration of articles published in one or in few specific journals, and it was possible to observe how the publications are widely spread in different countries. When classifying articles according the main topic of study, almost 30% were found to be focused on the importance of institutions and institutional environment, and according to the approach, almost 30% focused on IP, rather than on NIS or the RIS approaches. The selected publications of the last 7 seven years, supported the affirmation of various authors about the crescent importance of the RIS approach over the NIS, being the NIS still important and valuable for macro analysis. In relation to the instrumental case used for the study, no articles about Medellin RIS, have been published yet, nor any article about institutions and IP for the context of Colombia.

Conclusion

Innovation is an important topic not only for academic research agenda but also for policymaking and economic-social development (OECD, 2005). Since the first visions of Schumpeter (1947) about innovation, IA and IP, the concepts have gained attention from both practitioners and scholars (Kumar, Mudambi, & Gray, 2013). In the 90´s, the concept started to evolve and the current versions favor the systemic perspective (Cooke, Uranga & Etxebarria, 1997; Freeman, 2002). Evidence from the literature review showed that within the systemic view of innovation, the RIS approach is growing in importance (Cooke, Uranga & Etxebarria, 1997) and institutions are crucial to support the organizations within the RIS achieving the expected levels of IP (Oluwatobi, Efobi, Olurinola, & Alege, 2015; Pinto & Santos, 2013; Quiroga & Martin, 2016; Titarenko & Kirienko, 2014).

According to Kafouros et al. (2015), little research has been done in order to better understand the role of institutions and institutional framework for the RIS, and the effects on the IP of organizations, but the evidence found in the presented literature review showed that there are several empirical studies covering these matters in regions from different countries across the world. The number of studies assessing the topic have been steadily increasing since 2009, specially focusing on European and Asian cases, but Latin American countries have started to gain importance, and there are some articles from regions as Bolivia and Brazil. Most studies adopted a qualitative approach, and the three studies using quantitative approaches still have difficulties in the operationalization of the research variables, as in the quality of the measurement instruments implemented.

In order to advance in the knowledge on the subject, an empirical qualitative study, using the selected instrumental case from a Latin American country is appropriate, considering: (a) the significance of the topic and the relevance of further explaining the role of institutions for RIS`s IP, (b) the need to develop grounded hypotheses and instruments allowing rigorous quantitative research in the future, and (c) the observed crescent interest of literature on cases from Latin American countries.

Chapter 3: Method

Qualitative methods provide solid basis in the field of sociological research, as they help to understand the why and how of a particular phenomenon, while going beyond the what, where, when, or who (Denzin & Lincoln, 2005). Following a qualitative approach, and guided by the theoretical frameworks of the new institutional economics (North, 1992, 1995) and innovation economics (Atkinson & Ezell, 2012), the general aim of this research was to analyze and understand the role of institutions on the IP of the organizations in the RIS located in the city of Medellin.

Based on the brief description of the method presented in Chapter 1, this third chapter describe in detail the applied methodology and methods for this doctoral research. This chapter includes an explanation of the research design, the argumentation of pertinence of design, a contextualization of the research questions, the definition of geographical location, population and sampling process, the instrumentation for data collection, and the data analysis methods applied in order to answer the proposed research questions. Other elements relevant for the operationalization of the research method are discussed along the chapter, including the strategies to guarantee the validity and reliability on the study.

Research Design

This empirical basic research allowed to understand the role of the institutional framework in the IP of the quadruple helix in an RIS, using a qualitative approach, and this approach help provide further understanding of an specific phenomenon by offering diverse kinds of evidence and insights (Long & Godfrey, 2004). As for basic research, this type of research refers to the understanding of the foundation of phenomena (OECD, 2002), while empirical research allows to find answers to relatively insightful questions from reality (Cohen & Levin, 1989). Primary and secondary data were used in the study. Secondary data helped the construction of an appropriate theoretical and conceptual background to conduct

data collection and analysis, while primary data was the information collected from first-hand sources, in order to answer the research questions (Mooi & Sarstedt, 2011). In the study, the primary data was collected via semi-structured interviews, and the secondary data was taken only from academic databases.

For a precise methodological definition, the terms methodology and method require a precise differentiation when describing the research design. First, the term *research methodology* is often used as overall heading for doing research and for all associated procedures and it is also referred as research strategy (Gog, 2015, p. 33). Second, the term *research method* materialize from the methodology and refers to techniques and procedures to collect and analyze data (Gog, 2015, p. 34). In the current study, the instrumental case study was the research methodology, the semi-structured interview was the method for data collection, and the TA was the method implemented for data analysis.

A *case study* is "an empirical inquiry that investigates a phenomenon in depth and within its real-world context, especially [useful] when the boundaries between phenomenon and context may not be clearly evident" (Yin, 2014, p. 16). Moreover, in a *unique instrumental case study* the case is analyzed with detail and scrutinized in depth, in order to accomplish a general understanding of a phenomenon, as it is possible to get insight into the general question by studying a particular case, helping the researcher pursue an external or wider interest (Stake, 1995). Even though some authors have referred to the case study as a research method (Ellet, 2007; Gerring, 2004; Yin, 2014), Gog (2015) clarified that the case study approach is not only a research method; moreover, it becomes a methodology by offering a highly structured approach to the whole research process. Other authors that described the case study as a research methodology are Bryman and Bell (2011), Creswell (2013), and Jonker and Pennink (2010).

The *thematic analysis* (TA) method recommends processing the collected data to find and analyze patterns of information, which are known as themes. The themes must be associated with the main research question and are of great importance in the understanding of the phenomenon under study, and are composed of groups of codes that facilitate the exploration and conclusions (Braun & Clarke, 2006; Fereday & Muir-Cochrane, 2006). Based on Mieles, Tonon, and Alvarado (2012), the TA for the study will follow the next phases: (a) phase 1: sample selection; (b) phase 2: instrument design; (c) phase 3: data collection process; (d) phase 4: familiarization with data and information; (e) phase 5: generation of codes; and (f) phase 6: final structuring and exploration of themes.

Phase 1 is the *sample selection*, which was the identification of the proper organizations to be included in the analysis, and that allowed gathering the required data and observing differences between the variables of interest. The information about those organizations and the interaction with institutions of the RIS was obtained from the people in charge of innovation departments within those organizations, and 27 innovation managers from 18 organizations of diverse types were included in the study. Further details of the sampling process and its appropriateness is explained in the sampling frame section below.

Phase 2 was the *design of the instrument* for data collection, which for this case was semi-structured interviews. In this instrument, open-ended questions were specified, giving opportunities to the researcher to receive more nuances of the answers, permitting intertwining issues and collecting data in an organized way (Wengraf, 2001). The design of the instrument included the important themes defined with the pilot test, and was refined with the application of the subsequent semi-structured interviews. This phase involved various steps, which are explained in the section of instrumentation.

Phase 3 corresponds to the *data collection process*. In this phase, selected organizations were contacted, appointments with personnel in charge of innovation

departments were scheduled, and semi-structured interviews were used as a method for data collection. In total, 31 semi-structured interviews were performed in order to gather the information necessary for answering the research questions, and the complete data collection protocol is presented later in the section of data collection.

Phase 4 included the *familiarization with data and information*, which consists in the transcription, reading and re-reading of the material from the interviews, the revision of memos and hand written notes, and the annotation of general ideas (Braun & Clarke, 2006). This process allowed the comprehension of data collected and the mental structuring of important findings.

Phase 5 was related to the generation of codes, and this *coding process* required organizing the information into groups of the same meaning, where a *code* was the most simple element or segment of information that could be considered as significant in relation to the purpose of the study (Braun & Clarke, 2006). This phase consisted on reading the information repeatedly, looking for structures and meanings in order to make the most of its potential (Boyatzis, 1998). The full coding process will be explained in the data analysis section in this chapter.

Finally, phase 6 of the TA was the *exploration of themes*, and according to Boyatzys (1998), each *theme* must capture specific important meanings and information in relation to the research questions, representing a structured response level, which describes and organizes information, and can help in the interpretation of the characteristics or variables of interest in a phenomenon. Table 6 summarizes the research protocol, by presenting the instruments, the units of analysis and the unit of observation in face of the main research question and the global purpose of the research.

Table 6

Research Protocol

Main research question	Main objectives	Appropriate instruments	Units of analysis	Units of observation
What is the role of formal and informal institutions in an RIS for the IP of the organizations within the quadruple helix?	(a) To understand the role of formal and informal institutions for organizational IP within an RIS. (b) To propose emergent hypothesis about the impact of RIS´s formal and informal institutions over organizational IP in an RIS.	For data collection: Semi Structured Interviews. For data processing and analysis: Thematic and content analysis.	18 formal and informal organizations, representing different types of actors of the quadruple helix, and performing innovation within the RIS. The organizations were selected following a purposeful sampling process.	27 employees in charge of innovation departments within the selected organizations. 31 semi-structured interviews were performed.

Appropriateness of Design

The qualitative basic empirical study, performed trough the utilization of semi-structure interviews, provided the information needed to understand what is the role of formal and informal institutions in an RIS for the IP of the organizations within the quadruple helix. Basic research, according to the Frascati Manual (OECD, 2002) "is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts" (p. 30). Whereas, traditional points of view define the results of basic research as classified only for scientific publications and doctoral studies, as is the case for this research, recent studies have remarked that basic research may also support innovation and potentially lead to a variety of economic and social benefits (Zellner, 2013).

A qualitative study is one that uses qualitative methods during the collection and analysis of information, which are given in a visual, verbal or written form, rather than in numbers. Qualitative research is appropriate to study evidence-based phenomena and

systematic review of effectiveness, while the usage of semi-structured interviews reveal experiences within the qualitative exploration of a situation, perspectives on what counts, and contextual factors that may affect the achievement of the desired outcomes (Long & Godfrey, 2004). The risk of carrying out a qualitative study using unstructured interviews should be considered, since it is easy to deviate from the key issues or questions directly related to the research problem (Rabionet, 2011), reason why the semi-structured interview was considered suitable for this study.

Additionally, it is important to consider that a large part of the research on the RISs has observed the dynamics among the players and their interactions more in a theoretical than in an empirical way (Chung, 2002), but the empirical approach has gained greater relevance in recent studies (Lau & Lo, 2015). Empirical research in this study allowed for the generation of more credible conclusions, as it presents the possibility to establish regularities, empirically examine a phenomenon, and provide more realistic answers to insightful questions (Cohen & Levin, 1989). This research used a non-experimental empirical design, due the characteristics of the information required and the importance of the variables to be observed, as they interact in a real and natural environment. On the other hand, the use of an instrumental case study provided reliable information about a broader class (Flyvbjerg, 2006). Even though case studies can be applied in both quantitative and qualitative research (Gog, 2015); they are usually classified as qualitative, highlighting the in-depth understanding acquired predominantly by the usage of qualitative methods (Yin, 2013).

This empirically study was developed considering the instrumental case of the RIS of Medellin, and it is appropriate for the study as the city is currently in a highly structured innovation process, under the integral transformation project called Medellinnovation. Evidence produced during the last 4 years have ratified the success of this process and the

relevance of the phenomenon in different fields (ACI, 2014; Gómez, 2013; Moreno, 2013; Scott, 2012; URA, 2016).

In reference to the data collection and analysis method, TA is a common way of carrying out data analysis within the qualitative research, and a large number of authors agree that it is a very useful method to find the meanings and complex relationships in a series of qualitative information (Fereday & Muir-Cochrane, 2006). The coding process allowed to better understand the information obtained, prior to the process of definition and interpretation of themes (Denzin & Lincoln, 2005), as a good code captures the richness of the phenomenon and enables the structuration of the data when analyzing the themes (Boyatzis, 1998). Boyatzis conceptualized a theme as "a pattern in the information that at minimum describes and organizes the possible observations and at maximum interprets aspects of the phenomenon" (p. 161).

Semi-structured interviews will help to obtain the relevant information for the TA, as according to their nature, a guiding structure for the exploration of the topics was determined in advance. Within this technique, brief questions were specified, giving interviewees the opportunity to express freely and therefore provide insightful information (Wengraf, 2001), and allowing the researcher to deeply explore the phenomenon, intertwine issues and at the same time to collect data in a sort of organized way. Semi-structured interviews design was also useful in the next phases, especially during the generation of codes and themes in a coherent way, facilitating the completion of the TA.

In relation to the sampling process, since "generalization in a statistical sense is not a goal of qualitative research, probabilistic sampling is not necessary or even justifiable in qualitative research" (Merriam, & Tisdell, 2015, p. 254). Thus, purposeful sampling was the method selected for this qualitative study. This type of non-random sampling methods are reasonable as the researcher "expects mainly to use his data not to answer questions like 'how

much' and 'how often' but to solve qualitative problems, such as discovering what occurs, the implications of what occurs, and the relationships linking occurrences" (Honigmann, 1982, p. 84). Purposeful sampling served to the purpose of the research, since it is the sampling used when choosing the most indicated subjects for the sample is fundamental to obtain information about a very particular phenomenon (Merriam & Tisdell, 2015). Finally, given the scope of the study and the timing for its development, a cross-sectional design was the most appropriate. Cross-sectional studies are generally faster, easier and cheaper to perform than longitudinal studies and there is always the possibility of repeating them later to assess trends over time (Sedgwick, 2014).

Population

The organizations participating in the research were situated in Medellin, the third largest city in Colombia and the capital of the department of Antioquia, whose innovative activity has received multiple recognitions and awards during the last 5 years. Initially, in 2013, Medellin won the award for the most innovative city in the world given by ULI and The Wall Street Journal (Moreno, 2013), the same year in which it won the Veronica Rudge Urbanism Prize awarded by Harvard University for its Urban Development, and was proclaimed the preferred corporate destination in South America (Gómez, 2013). In 2014, Medellin was classified as one of the best cities to live in South America according to the Smart Cities index by Indra Systems (ACI, 2014). In 2015, Medellin was the city with the highest rate of innovation growing indexes in the world (2thinknow, 2015), and also in 2016 won the Lee Kuan Yew World City Prize, an award granted by the Urban Redevelopment Authority (URA) that distinguishes and awards the determination to stimulate sustainable urban development and innovative urban solutions (URA, 2016).

Finally, it is important to highlight that Medellin RIS structure has been carefully designed and improved, considering the practices and institutions common to the biggest and

most successful regional innovation systems of the world, and adapting them to context (Pineda & Scheel, 2010). The RIS of the city provides a good characterization, not only of the local arena or behaviors, but also of those related to different regions or contexts, what allows the results to be useful or, to some extent, applicable to other RIS in different regions.

When identifying the population, the first source consulted was the database of the Medellin-Antioquia Chamber of Commerce (CCMA, 2015). The CCMA reported 119,268 organizations registered and renewed, by December 31, 2015, of which, more than 89,164 are located in Medellin. However, this number includes very small and sometimes non-operating firms, so in order to do a more efficient delimitation of the population of the study the emphasis was given to organizations interacting with Medellin's RIS. There are approximately 2,200 firms that have signed the Innovation Pact of Ruta N, since its beginnings on September 9 of 2014 (Ruta N, 2016). Signing the Innovation Pact of Ruta N, means that the organizations made a commitment that for 2021 they "will be investing at least 3% of their sales back into activities in science, technology, and innovation" (Wade, 2016, p.1). However, it is important to acknowledge that the conceptual definition of the IS confines the system to the set of players, institutions, and networks that are actually participating and supporting the innovation process (Markard & Truffer, 2008), and this is the reason why, the condition was to include in the study only organizations that have signed the Innovation Pact of Ruta N.

Informed Consent

The data collection procedure assured that the participants read, understand, and sign the informed consent, as a signal of compliance (see Appendix C). The informed consent clearly stated the objectives of the study, the interview procedures (including recording of the interview session), confidentiality and commitments in relation to the information provided and to the publication of the results of the study. The informants were given a copy of the

informed consent and the other copy was filed physically and scanned for the research digital

archive and database.

Sampling Frame and Sample Characteristics

The usual method for objects or individuals selection in qualitative research is not

probabilistic sampling nor convenience sampling, but the purposeful sampling (Palys, 2008).

In the *purposeful sampling*, the sample is deliberately selected given that they are adequate

when providing the necessary information to address the research problem and respond to the

main question of the study (Creswell, 2013). According to the Maxwell (2012) "selecting

settings, and individuals that can provide you with the information that you need to answer

your research questions is the most important consideration in qualitative selection decisions"

(p. 97).

In this study, a purposeful sampling was applied considering four main goals, which

were in line with recommendations by Maxwell (2012). The first goal was to attain adequate

variability to ensure that exemplarity and typicality of the environments, actors and selected

activities. The second goal was to adequately capture the heterogeneity in the population and

ensure that the conclusions effectively by representing the entire range of variation, rather

than only including the typical members. The third goal was to carefully select individuals or

cases that are critical for testing the theories underlying the study and developing consistent

propositions. The fourth objective of the purposeful selection was to find interesting contrasts

and make comparisons that would allow a better understanding of the differences between the

different actors and situations, and their motives. According to Palys (2008), it is important to

define the dimensions of variation in the population that are most relevant to the study and

systematically select individuals or settings that represent the most relevant possible

variations on these dimensions. For the present study, it is important to include formal and

informal organizations, and organizations that represent the different types of actors in

quadruple helix model; university, industry, government, and civil society (see Table 7).

These organizations were included in the sample considering three standards: (a) they

have signed the innovation pact of Ruta N, (b) they are companies engaged in IP, and (c) they

represent one of the four different types of actors in the quadruple helix model.

Table 7

Organizations Included in the Sample

	Formal		Informal
Industry	University	Government	Society
Synapsis	Universidad EIA	Ruta N	ECSIM
THOT Group	EAFIT	Tecnnova	UEE committee
Turboboy		EPM	
Capitalia			
Premex			
ANDI			
AIA			
Industrias San Pedro			
Nacional de Chocolates			
Energia y Potencia			
Renting Colombia			

In relation to the sampling process, it is important to clarify that while the *units of*

analysis were formal and informal organizations participating the RIS of Medellin, the *units*

of observation were employees managing innovation departments within those organizations,

and one or two employees from each organization were interviewed.

In relation to the sample size, there is not an exact answer to the question of how

many organizations and participants should be included, as according to Merriam and Tisdell

(2015), as it relies on the scope of the study, the main research questions, the type of

information being collected, the proposed processing, and the set of resources for the

realization of the study. Purposive sample sizes for qualitative research should be determined

according to the achievement of data saturation, also known as redundancy (Fossey et al., 2002; Mason, 2010), and this happens when "you begin hearing the same responses to your interview questions or seeing the same behaviors in observations; no new insights are forthcoming" (Merriam & Tisdell, 2015, p. 101). In order to recognize that your data is saturated, you must engage in the data collection along with the analysis (Merriam & Tisdell, 2015) and for the present study, saturation was achieved after the application of 31 interviews, from 27 interviewees, representing 18 organizations within the quadruple helix of the RIS.

In those cases in which any of the selected organizations refused to participate on the study for any reason, they were replaced by selecting another organization with similar characteristics, and this was the case for two organizations initially selected for the sample.

Confidentiality

To protect the privacy of participants, the names of the interviewees are not included in the report and are replaced with pseudonyms. Interviewees were asked in the informed consent for permission to published organization names as part of the sample, but in the final report specific information will be published in a form that it could not be personally related to a particular interviewee or organization.

Instrumentation

This section will describe the procedures used for the data collection, the semi-structured interview protocol, the pilot test interview, and the final design for data collection instrument.

The application of the semi-structures interviews was performed by following the six stages delineated by Rabionet (2011): (a) selecting the type of interview, (b) establishing ethical guidelines, (c) crafting the interview protocol, (d) conducting and recording the interview, (e) analyzing and summarizing the interview, and (f) reporting the findings (p.

203). The first three steps are presented in this section, while the last three stages are part or the last chapters of the thesis.

Ethical guidelines. The ethical issues from interviews emerge from the complexities of the intimacy and the inquiry of topics that could be sensitive to the interviewee, as "the human interaction in the interview affects the interviewees and the knowledge produced by an interview inquiry affects our understanding of the human condition" (Kvale, 2008, p. 24). One must consider the moral and ethical components of an interview, given the means and ends for which it is performed (Rabionet, 2011), and the ethical considerations within this research were designed taking into account the guidelines proposed by Kvale (2008).

In the first place, this research and the information derived from the interview are expected to have a higher purpose in terms of improving the social situation. In the second place, the informed consent of the participants was fully explained and obtained in each case, ensuring the confidentiality of the particular answers of each respondent. In addition, in the third place, the interview was designed in such a way, that it did not generate stress on the subjects nor forced them to respond to those questions they did not want to answer. Fourth, the report guarantees the veracity of the information, preserving the statements made by the interviewees while protecting their personal identity. Finally, in relation to ethical issues related to the analysis, this phase included the opportunity for interviewees to express their opinion about how their statements were interpreted and used. A critical ethical issue, as said by Kvale´s (2008), is the verification, and to accomplish it, the researcher reported the knowledge as accurate as possible, acknowledging contradicting findings as well.

Interview protocol. Research interviews were performed personally, and interviewees were contacted by phone and/or email and asked for an appointment. Each interview had an estimated duration of 1 hour and a half, and some extended up to 2 hours. The interview checklist included the next steps: (a) presentation, (b) warm up, (c) inform consent and

confidentiality clarifications, (d) demographic questions, (e) discussion of the main topics, and (f) closing. For the sake of clarity, the demographic questions were the same for every interviewee, and the format for the collection of demographic data of the organizations included in the sample is shown in Appendix F. Additionally, as suggested by Merriam and Tisdell (2015), the crucial issues studied via semi-structured questions were also deeply explored using unstructured questions; and as recommended by Kvale (2008), all interviews were audio recorded with consent of participants, while important notes were taken in a field diary.

The main topics to be discussed during the interview were derived from the research questions and the etic categories found in the literature review. There were six main topics analyzed in each interview: (a) the definition of regional innovation system, (b) the reasons to participate in an RIS dynamic, (c) the formal institutions existing in the RIS and their importance, (d) the informal institutions existing in the RIS and their importance, (e) the institutions positively influencing the IP, (f) the institutions negatively influencing the IP, and g) the type of institutions (formal or informal) influencing IP the most. Table 8 shows the summarized protocol for each semi-structured interview and the full interview guide, including questions and topics, is presented in Appendix D.

Table 8

In-depth Interviews Protocol

Interview Type	Sample Contact	Estimated Time	Data Collection	Topics to be Analyze
Personal Semi-structured interview	By phone and/or email.	1 hour and a half to 2 hours	Interviews were recorded. Handwritten notes were taken in a field diary	1) Concept of regional innovation system 2) Reasons to participate in the RIS 3) Formal institutions affecting IP in the RIS 4) Informal institutions affecting IP in the RIS 5) Institutions positively influencing IA 6) Institutions negatively influencing IA 7) Type of institutions influencing IP the most

These pre-determined topics helped to achieve a better structure for the compilation of the information, as well as the identification of emic categories to accomplish the research purpose. All interviews followed the same protocol in order to ensure systematic collection of information, as complete and organize as possible.

Pilot interview. The pilot interview not only helped in the acquisition of some practice in the interviewing process, but also became crucial to determine the changes needed, the design of the interview guide and an adequate structure for the instrument. Following suggestions of Kvale (2008), Merriam and Tisdell (2015), after the pilot interview, there was an improvement of those questions that were confusing and need rewording, and those questions that yielded useless data were discarded. Figure 2 shows the structure and the information retrieved after processing the information and feedback obtained during the pilot interview.
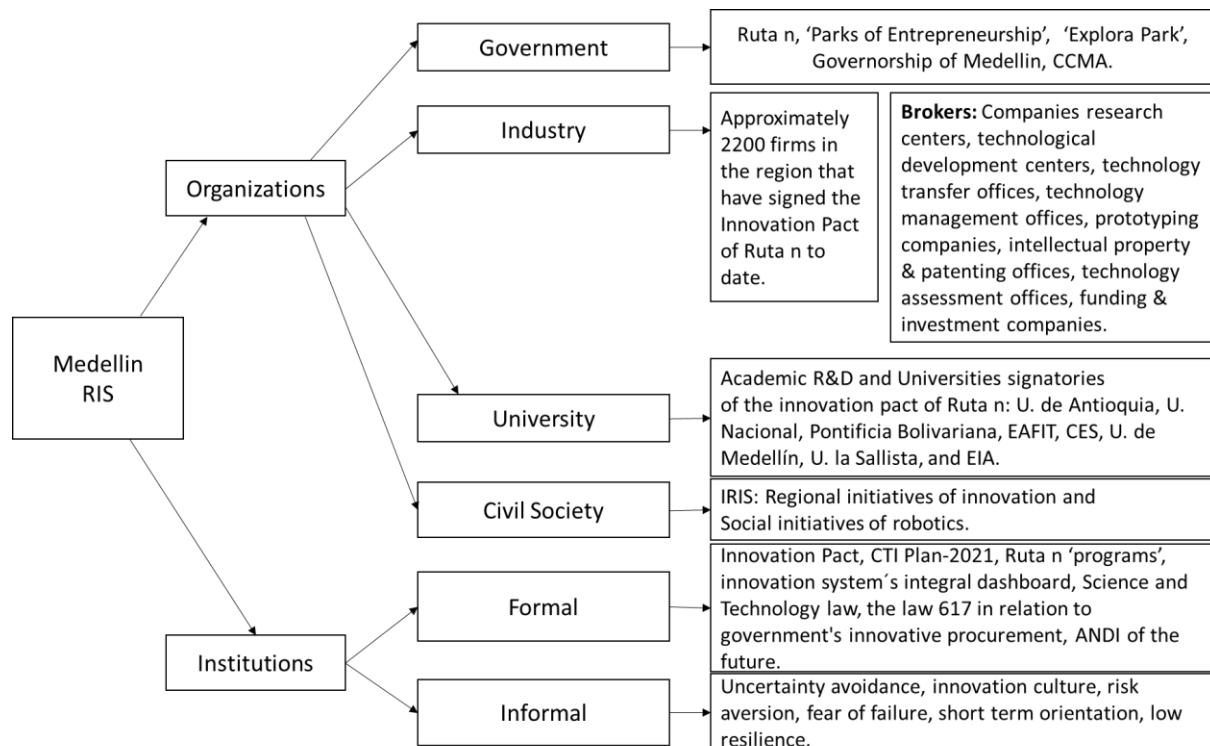
Figure 2. Structure and initial information retrieved from the processing of the pilot interview.

The pilot interview was done to Juan Camilo Quintero, and it was used as the pilot test of the instrument for the study, with his authorization. Camilo Quintero was the president of the main connecting organization of Medellin's RIS; Ruta N, was also president of Tecnnova, an important innovation intermediary of the RIS, and is the current Director of Innovation of the National Association of Entrepreneurs of Colombia (ANDI). The pilot interview helped to make the necessary adjustments and changes; and as a result, some questions were modified and others were included in the interview guide. The changes were incorporated and the final version of the instrument structure can be consulted in Appendix D. Audio recording and full transcription of the material obtained in the pilot interview was storage as evidence of the process, and the complete description of the analysis performed to the pilot interview are presented in Appendix E.

Data Collection

In line with Creswell (2013), the data collection steps included: (a) setting the boundaries for the information gathering, (b) collecting information through semi-structured interviews, and (c) establishing the protocol for recording and storing the information. In a TA, data collection and data analysis should be parallel processes, as the research may be nurtured with emerging findings and there is a need to identify the saturation point, which is a condition to determine the adequacy of the final sample size considered for the study. During face-to-face semi-structured interviews, the interviewer presented open-ended questions, intended to elicit views and opinions from the participants. For the case of the study only voice recordings from interviews were taken, as no video recordings or pictures during interviews were considered necessary. It is important to acknowledge that based on Leung (2015), this qualitative study used the six evaluation criteria for achieving validity and reliability, which are: (a) credibility, (b) possibility of confirmation, (c) meaning in context, (d) saturation, (e) triangulation, and (f) possibility of transference.

The first criteria, credibility, comes from the findings sustained on evidence, which includes objective, subjective, and intersubjective reality. The second, the possibility of confirmation, includes the confirmation with the informants of the findings and interpretations of the researcher through spaces of feedback. Third, the meaning in context derives from taking into account the particular context in which the research was developed in order to achieve an adequate understanding and interpretation of findings and their abstraction for the possibility of applying the results in similar contexts. The fourth criteria, saturation, occurred as experiences, opinions, perceptions, and facts discussed, appear repeatedly in data collected. The fifth, triangulation, comes from the immersion in the phenomena to know them thoroughly and exhaustively, obtaining the same or similar information through various forms of inquiry. Finally, the sixth criteria is the possibility of transference, which refers to the particular results of a qualitative research that can be transferred to another context or similar situation and still preserve the importance of meanings, interpretations and inferences of the whole study.

In reference to this last point, the purpose of qualitative research is not to produce accurate generalizations to an entire population, but rather to comprehend and in-depth knowledge of particular phenomena (Leung, 2015), so the transfer criterion focuses on the general similarities of the findings under specific conditions, contexts or circumstances, that may be useful for analyzing similar cases. In addition, as this is an instrumental case study, it was important to provide insight into a general phenomenon and help refine actual theories (Baxter & Jack, 2008).

In relation to external validity, conclusions to each questions will be supported on the findings presented on chapter 4, as well as on the information gathered in the literature review, the theoretical framework and on some previous studies, as a mean to triangulate

them, providing validity (Merriam & Tisdell, 2015) and possible contextualized generalization in future case study evaluations (Yin, 2013).

Regarding the data systematization, after each interview, the recordings were storage using an iCloud service for security, as well as the transcriptions, avoiding any loss of any valuable information. To increase the reliability of the study, careful labeling and precise data collection notes were added to all material collected, allowing triangulation and direct clear revision of research evidence for each interview at any time, also field notes were taken into account during the data processing, analysis and conclusions. The overall data set of the study is composed by: (a) the informed consent forms signed by interviewees, (b) the demographic data forms, (c) the recordings of the interviews, (d) the interview transcripts, and (e) the field notes. All data were digitally archived. Printed copies, such as the signed consent forms and the field notes, were kept in physical archives after being scanned.

Yin (2013) remarks the importance of keep the chain of evidence during the analysis, explicitly showing the relationship between the research questions, the information obtained and the conclusions, to ensure the reliability of the study. The essential purpose of this chain of evidence is assuring that referenced sources are included in the database, database makes it possible to identify the circumstances in which the information was obtained, and all the information is collected in accordance with protocol procedures. All of these aspects were taken into account during the data collection and storage process. Data were collected during the second semester of 2017 and first trimester of 2018.

Data Analysis

According to Fereday and Muir-Cochrane (2006), two methods of analysis can be used in a TA; the first is through an inductive approach based on the data, as expressed by Boyatzis (1998) and the other is through the deductive coding described by Crabtree and Miller (1999). The data analysis in this study used a combined inductive and deductive

technique, considering etic and emic categories trough the data analysis process. According to Fereday and Muir-Cochrane (2006), using a hybrid approach to TA demonstrates rigor in the process and the findings. The phases conducted for the data processing and analysis is shown in Table 9.

Table 9

Phases in the Data Analysis

Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6
Full transcription of the interview recordings. Reading of transcripts and revision of field notes.	Use of ATLAS.ti to structure data collected (interview transcripts) and identifying patterns and initial codes for each theme.	Use of theoretical framework, notes from field diary, and interview´s transcripts for refinement of the coding. Feedback from interviewees and clarification of confusing terms.	Literature review to explore previous studies exploring the identified codes and variables in order to refine, reorganize, and rename codes appropriately, considering the theoretical background. Feedback from interviewees	Definition of final codes within each theme, making the description and analysis with cross verification or triangulation with previous academic literature.	Content Analysis, including segmented explanations for the different actors of the quadruple helix. Radar charts to simplify and visually support content analyses.

The coding process is an important phase of the TA, and it was systematically implemented by following the guidelines suggested by Braun and Clarke (2006). First, the major possible number of patterns in the information were codified, incorporating enough information in each code so as not to lose perspective of the context. Second, some data extracts were coded more than once when applying to different themes. A hybrid approach was used, implementing two forms of coding: inductive, which was made from the data; also known as emic, and theoretical coding, that came from the specific theoretical background of the research topic; also known as etic (Braun & Clarke, 2006).

A computer assisted qualitative data analysis (CAQDAS) was performed, supported on ATLAS.ti 7. Software for Windows, as according to Silver and Lewins (2014), even though the use of customized software and CAQDAS is not strictly required in order to conduct robust analysis, its use enables the researcher to be more transparent in the process of analysis. This software helped to keep track of the tasks the researcher engaged in, and their sequence, and it allowed the documentation to be more easily illustrated and organized than working manually. In addition, the overall process of coding, iteration and refinement to achieve the final optimal structure for each theme is evidenced in the excel file, used for data systematization. The excel file contains the process, the final structures of coding for each theme, the complete matrix of data represented in a numerical and graphical way, and it was a prerequisite for the elaboration of radar diagrams used to enrich the content analysis, and this graphs were made by using MATLAB software 2017a 62bits. Radar diagrams are comprehensive evaluation methods, which provide ease of visualization, considering axes with scales where the value can be identified in each of the points of analysis by each group of individuals in the sample (Phillips & Dudik, 2008), that for this case were the interviewees representing each type of actor within the quadruple helix. To visualize the radar diagram, lines are used to connect the analysis points on the axes for each group of individuals, making it easier to understand the trends that are presented in the data (Saary, 2008).

Validity and Reliability

Wengraf (2001) made certain suggestions to increase the validity of the content analysis carried out with the information obtained from interviews. First, researchers must report the study criteria, decide the initial sample size, and have clear criteria to determine the saturation of the information. Second, proper structure should be given to the presentation of the results to ensure the verifiability, veracity and impartiality. Finally, there must be sufficient evidence of the decisions made for the analysis of the information.

Triangulation is an effective method for the interpretation of the results and for reassuring reliability of research (Golafshani, 2003), and as said by Mathison (1988), "Triangulation has risen an important methodological issue in naturalistic and qualitative approaches to evaluation [in order to] control bias and establishing valid propositions because traditional scientific techniques are incompatible with this alternate epistemology" (p. 13). For present study, triangulation was assured by triangulating the results derived from the TA with the existent literature, and results from other researchers. The categories related to the formal and informal institutions that emerged from data collected, were also verified and triangulated with results of other studies and with theories related to the subject, in order to achieve reliability in the study, as well as a logic and sound contribution the current literature on RISs. Finally, Yin (2013) said that reliability of a study is supported on the chain of evidence during the analysis, explicitly showing the relationship between the research questions, the information obtained and the conclusions, all conditions accomplished for the actual case.

Summary

This research used a qualitative approach to describe the role of the institutional framework for the IP of organizations within the quadruple helix of an RIS, by identifying the formal and informal institutions important for the RIS`s IP, and how those institutions positively or negatively affect the IP of organizations. Data collection was performed via semi-structured interviews and data analysis was performed using the TA methodology. The TA and the coding process were performed under a hybrid approach, coding from emic and etic categories, and using CAQDAS, ATLAS.ti 7 for Windows and MATLAB software 2017a 62bits. According to a purposeful sampling process, the study included only those organizations that have signed the innovation pact of Ruta N and represented one of the four types of actors within the quadruple helix model.

The analysis units, organizations, included in the sample were described in this chapter, including 18 organizations meeting all criteria predefined. The units of observation were 27 innovation managers or personnel in charge of innovation areas within the selected organizations. These individuals provided the crucial information needed to answer the research questions. Finally, after completing the fieldwork, all the information obtained from different inquiries was organized and storage in digital formats, enabling means of evidence, easy consultation, and research reliability.

Chapter 4: Results

According to the methodology proposed and implemented, in order to accomplish the research objective, which was to understand the role of institutions in an RIS and their impact on the IP of organizations within the quadruple helix, data was gathered by a qualitative approach with semi structured interviews, developed with 27 participants in charge of the innovation departments from 18 innovative organizations actively participating in Medellin´s RIS. Following the parameters of a purposeful sampling, there is a representation of each type of actor within the quadruple helix of the RIS, and for the last analysis presented in this chapter the organizations were classified under this approach as university, industry, government, or civil society (Afonso, et al., 2012). The TA, which was selected, as it is an appropriate method for data analysis, is useful for answering research questions with a scope greater than that one of an individual case, allowing the categories to emerge from the information collected (Braun & Clarke, 2006; Guest, MacQueen, & Namey, 2011). The process for data collection and analysis used in the research, allowed mapping the institutional framework of an RIS and identifying emerging propositions, constituting the base for a grounded theory about institutions, institutional framework and RISs` performance. Additionally, segmented analysis according to the type of actor within the quadruple helix, provided insightful information about the research topic and helped contextualized the phenomenon with an appropriate theoretical approach. The institutional framework and taxonomy derived from the TA were triangulated with existent literature providing robust results, and refinement is possible in future research, by performing the same study in different contexts, so the resultant structure is expected to become a commonly accepted guide to study Institutions, Institutional Framework, and IP in RISs.

In this chapter, the results obtained from fieldwork are systematically presented in accordance with the TA method applied, and this chapter is structured as follows: (a)

familiarization with data and information, (b) definition of general themes or thematic axes, (c) identification of codes within themes, and (d) segmented content analysis exploration (post-hoc analysis).

Stage 1: Familiarization with Data and Information

After semi structured interviews were applied and recorded, each interview recording was transcribed using a standardized format. Transcriptions where revised and in some cases when missing information or misinterpretations were detected, the interviewees where contacted for a second, or even a third time in some cases, seeking to assure the precision of the information collected and fill any information gaps, before proceeding with next stages. Handwritten notes and memos taken during the interviews, where organized, and considered during the first stage of analysis, as they were crucial for the process (Charmaz, & Henwood, 2017). Before starting data processing and analysis for results and conclusions, the information collected was well-structured, organized and storage in digital formats, enabling easy consultation and means of evidence for supporting reliability on the study.

Stage 2: Definition of Themes

In the stage 2, themes for data analysis were defined, and a theme is an implicit topic that organizes a group of repeating ideas, enabling researchers to answer the research questions (Ryan & Bernard, 2003). A theme is comprised by the diverse codes that present a shared meaning, allowing the unification and desegregation of ideas around the topic under study (Bradley, Curry, & Devers, 2007; Buetow, 2010). After the detailed revision and systematization of the information gathered, seven general themes were identified and appropriate defined considering: (a) the research questions, (b) the literature review, (c) the themes that emerged from the pilot interview; and (d) the refinement allowed by the application of every interview. The final themes, that are the main axis of the whole analysis, are presented in Table 10.

Table 10

Defined Themes after data analysis

Number	Theme	Definition and importance
1	Definition of an RIS	Interviewees defined an RIS according to their knowledge and opinion. This is important in order to identify how they incorporate the institutions or institutional framework when defining an RIS or if they do not.
2	Reasons to engage and participate in an RIS	Interviewees explained the reasons they observe in the process of engaging and participating of an RIS dynamics, for the case studied trough the signing of an innovation pact (formal institution that defines the participation and membership commitment with the particular RIS). This is important in order to observe the reasons to adhere to the most general formal institution of the RIS and the role of this formal institution for the actors of the quadruple helix.
3	Formal institutions influencing the IP of an RIS	Interviewees identified the formal institutions influencing the innovations performance of organizations within the quadruple helix and the role of those institutions in a regional innovation system. This information is crucial as it directly helps to solve the central research question, and some of the specific questions.
4	Informal institutions influencing the IP of an RIS	Interviewees identified the informal institutions influencing the innovations performance of organizations within the quadruple helix and the role of those institutions in a regional innovation system. This information is crucial as it directly helps to answer the main research question, and some of the specific questions.
5	Institutions that positively influence the IP of an RIS	Interviewees identified which institutions are observed to have a positive effect on innovation by increasing innovation performance levels of all actors within the RIS. This information allows the emergence of hypothesis that are interesting for future quantitative studies to test.
6	Institutions that negatively influence the IP of an RIS	Interviewees identified which institutions are observed to have a negative effect on innovation by decreasing innovation performance levels of all actors within the RIS. This information allows the emergence of hypothesis that are interesting for future quantitative studies to test.
7	Institutions with greater effect on the RIS (formal vs informal)	Interviewees defined according to their knowledge which kind of institutions (formal or informal) exert a greater effect on the innovation performance of the whole RIS.

It is important to remark that after the pilot test, during the fieldwork, no additional themes emerged from interviews; when subjects were asked for any additional aspect or theme that they considered necessary for the study, no one suggest anything different, so no additional emic themes arouse from data collected at this stage.

Stage 3: Identification of Codes

In the coding process, etic and emic codes were considered, as some codes coincide with the previous literature on the topic while some other codes emerged from the data collected via interviews during the research. Coding is the result of a process of filtration, and the process of coding was based on iteration; as during the data collection and the data analysis, there was always a quest for achieve the best code structures. After the iteration process, final codes were refined and some codes were removed or merged with others when they had similar meaning of already existing codes, or they were not actually related to the study nor valuable for the solution of the research questions. In the following steps, the resulting codes are presented in tables, and are ranked by order, according to the number of respondents who have mentioned the code; then for the case of all tables, in the first positions the codes with the most reprisals are located and in the last positions the codes with the least repetitions among participants.

Definition of an RIS.

For the first theme that is the "Definition of an RIS", the analysis performed lead to the identification of nine codes, and Table 11 contains the codes, their explanation and the verbatims extracted from the interviews. These definitions are important as the allowed to identify how participants of the study incorporate the institutions or the institutional framework when defining an RIS or if on the contrary they do not considers institutional aspects.

Table 11

Codes for "Definition of an RIS"

Codes	Explanation	Verbatims from interviews
1. Is the articulation of different elements to increase innovation performance	Interviewees defined the RIS as the articulation of various elements and actors with the goal of increasing innovation levels.	"To articulate a number of different and diverse actors ... they have to be very diverse, they cannot be all universities, no! They have to be funders, the government, the companies; they have to be the research groups ... "P1."¨When the actors of a region of a city are connected to maximize the innovation capacity of that society" P10. "Platform where they converge, where they interact and collaborate with diverse actors with different purposes and roles" P12. "A healthy ecosystem of innovation is one in which ideas, capital, talent and ideas freely circulate and new and better business models are developed" P26.
2. It is a network platform	Interviewees defined the RIS as a platform to boost networking and team work between RIS's actors	"A system where all would correlate to achieve development" P2. "Is a network where we all partake, we connect, we define ourselves" P14. "In an innovation ecosystem there must be transparency and tranquility in the communication, to be able to share our problems, our challenges and to be able to team up" P26.
3. It is a social system to support society welfare	Interviewees defined the RIS as a system that should focus on having a positive impact on society welfare and wellness.	"Generate and/or use new knowledge to produce well-being for that society" P10. "Innovation not only translates into knowledge transfer with a commercial purpose, translates into the well-being of the population" P23. "There are many products and proposals that really impact and change societies" P25.
4. It is a mechanism to create innovation culture	Interviewees defined the RIS as a system that work primarily on informal institutions to help create mentality and innovation culture	"We started to believe the story that we are the most innovative city, this has begun to influence much in the way in which people develop their tasks "P6." Is more a machine of cultural transformation because ... if you look in the long term, innovation is not something that the government can do or that someone can do for you, innovation works in an organization when every person involves innovation in his work he "P10 ..." a system of innovation involves a cultural issue" P18.
5. It is a set of resources to support innovation	Interviewees defined the RIS as a set of resources for the innovation activities	"It is a set of people, processes and resources, ready and organized… to motivate and bring innovation" P17. "It is a system that provides the resources and capabilities needed by organizations to enhance their innovative capacity" P31.

Table 11

Codes for "Definition of an RIS" (continuation)

Codes	Explanation	Verbatims from interviews
6. It is a methodical system with continues process defined	Interviewees defined the RIS as a system with methodical and well defined continued processes	"It is a measurable and quantifiable platform" P2. "It is a set of actors that are organized, which have defined roles, policies and processes for innovation P24. "You must have a plan or a route, because the most dangerous thing is trying to innovate without having a framework" P29
7. It is a non-structured entity with chaos dynamic	Interviewees defined the RIS as chaos dynamic system were process are nonlinear and non-structured	"It is not possible to articulate an ecosystem by decree" P7. "It is an unstructured entity with dynamics of chaos." Q9. "We cannot pretend that innovation can order a system, that is like trying to sort a hectare forest" P26.
8. It is a system to improve innovation capabilities	Interviewees defined the RIS as a system that help boost innovation capabilities of organizations by offering tools, training and knowledge	"The ecosystem is all that helps organizations open their eyes to what can be leveraged ... there are a lot of opportunities, you as a company have to filter them to be taken advantage of" P11 ..." is a system that provides resources and capabilities for organizations to enhance their innovative capacity. "P31.
9. It is a system with a common goal	Interviewees defined the RIS as a system that should have a clear common goal, which needs to be communicated to all participants of the system.	"Supporting or seeking the realization of a single objective and it is that the entire platform in general can grow, prosper, evolve and progress" P12. "It has a common objective and its components are related to each other to meet that or those objectives" P16. "It is a model in which all the actors of the ecosystem are aiming at a common goal" P22.

Reasons to engage and participate in an RIS.

For the second theme that is the "Reasons to engage in an RIS", the informants expressed the motivations to engage and actively participate in the RIS dynamics and the analysis lead to the identification of nine codes or motivations. In Table 12, the identified codes, their explanation and the verbatims from the interviews are presented. This information was useful as it allowed observing the reasons to adhere to the most general formal institution of the RIS, the Innovation Pact, and the role of this and other formal and informal institutions for the actors of the quadruple helix, when deciding whether to participate or not in RIS's dynamics.

Table 12

Codes for "Reasons to engage in an RIS"

Codes	Explanation	Verbatims from interviews
1. For connections and networking	Organizations value the possibilities to collaborate and access networks for collaboration	"Innovation is not done in an isolated way, the innovation is an effort that has to be done in network, it has to be done through alliances, it is an effort that has to unite synergies" P1. "…and be on the net. That to us seemed too important and there have been very good connections" P14. "It is like finding those entities that can support, find those entities with which one can generate alliances for the internal projects that have the organization... is basically networking " P28.
2. For an organizational declaration towards innovation	Organizations recognize the importance of innovation and declare an internal commitment to innovate	"I declared Innovation as vital in my future" P10. "It is a declaration also from the top management group that they are committed to the city and the region around betting on innovation" P25. "Because we believe in the regional articulation and in the sum of all efforts to improve the competitiveness and productivity of the city of Medellin, and we believe that innovation is a path" P23.
3. As an obligation or for inertia	Organizations feel pressure to participate in the RIS or do it just to maintain the mainstream without truly committing to it	"We signed it but… the relationship stayed on Stand By, as we were not able to deepen more in addition to signing it" P4. "The signature is because it is important … well, for us I think not … that is to say; the signature was because … how could we not signed it?" P19. "More like being in the ecosystem than anything else, not really how to find any benefit in that, but it was like more for being there." P28.
4. As symbolic public act	Organizations want others to see they support innovation and belong to the RIS mainly as a matter of visibility	"To walk and to send a message to society, that that [innovation] is important" P3. "It is an important symbolic element of the city" P13. "That is to say; Look this is necessary for the region, look it's worth to do, that [pact] make it visible" P17. "It is like a symbolic exercise for the commitment of the institutions that are in the ecosystem" P24
5. As a way to identify capabilities and opportunities	Organizations want to assess their actual internal capabilities for innovation in order to understand risks and opportunities	"To find the opportunities that the ecosystem was offering [...] To see what we could adapt to" P18. "To know what Antioquia is doing, to know what the topic of innovation is, and how we can adopt this innovation in the company and work with the ecosystem, reaching the market "P14."We took GIES as a way to make an assessment of our innovation system, and to evaluate how we were, what we were doing, and what we could add" P11.

Table 12

Codes for "Reasons to engage in an RIS" (continuation)

Codes	Explanation	Verbatims from interviews
6. For the access to financial support and mentoring	Organizations understand the opportunities in terms of financing and expert advisory that the RIS offers to its members	"Then, it should also be like the support that they give [...] to other organizations or companies for the innovation issues" P16. "There is a fund that has some investors and they make rounds [...] They are the nets of Business Angels "P7."Yes, it's for access to aid, support and resources" P31.
7. As a commitment for future investment	Organizations truly commit to progressively rise their investment in innovation projects	"I will measure how much I invest in innovation and how many results it generates, and as I am already measuring, I will commit to invest more each year" P10. "Particularly in [the organization], great efforts have been made for research … for investment in research and development" P23. "As an economic commitment and an interest from the institution" P17.
8. For education and training access	Organizations seek the possibilities to learn more about innovation methodologies and how to achieve innovation performance	"They bring some speakers that are incredible. I was at a conference where a woman from the Inter-American Development Bank came with an incredible experience, also a man from Holland who spoke about the angel investors" P4. "The first thing they do is access training in all the innovation topics" P16. "How to find the opportunities that the ecosystem was offering in training the staff to see what we could adapt [for the firm]" P18.
9. As a way to contribute to the system	Organizations want to offer their knowledge and capabilities to support others and boost innovation performance of the RIS	"To join and subscribe to the agreement, let's say in order to give back something of what we have done and contribute" P2. "It's supposed that the university should […] also be like the support to other organizations or companies for the innovation matters" P16. "We are committed to the innovation system of the city" P22.

Formal institutions influencing the IP of an RIS.

For the third theme that is the "Formal institutions influencing the IP of an RIS", after the analysis of the data 17 codes were defined, which correspond to the 17 formal institutions operating in the RIS, identified by participants, and the codes for this theme, their definitions and the related verbatims are shown in Table 13. For this section, the 115 emic codes that emerged from the data collected were group into "families" according to the type of formal institution they belong to, for an appropriate analysis. Seeking theoretical congruence, the

process of categorization was carried out considering the etic categories found in the

scientific literature on the subject. The complete emic coding, before grouping and refining,

is presented in Appendix G.

Table 13

Codes for "Formal institutions influencing the IP of an RIS"

Codes	Explanation	Verbatims from interviews
1. Investment, incubation and acceleration	Resources that are continuously available for supporting innovation projects of organizations	"You have to stimulate it [innovation] to be generated, then there are the venture capitals, those are angel investors" P10. "There are also incubators and what we know as seed capital funds […] angel investors, capital funds for entrepreneurship" P12. "Business development centers are a place that conglomerates prospective, leadership capacity, entrepreneurship training, eh ... investment opportunities, funds…" P13.
2. Laws and regulations	Laws and regulations affecting (positively or negatively) the implementation of innovation plans and projects	"Laws such as tax exemptions" P7. "The national science and technology law" P13. "I also see that the law of tax incentives, which support the research and development, given that companies can access certain benefits or certain advantages at the tax level when they are embarked on innovation projects" P22.
3. Innovation policies and plans	National and regional development plans, policies and innovation strategies	"The government is not using the tools it should be to develop good entrepreneurship policies" P2. "All the development plans […] since they have maintained that line of entrepreneurship, business transformation and innovation" P9. "The science technology and innovation plan is undoubtedly a key point. The economic development policy of the public administration" P14.
4. Calls for innovation projects	Particular contests and calls inviting organizations to participate in or develop innovation projects	"They […] have released many calls already, not only for research but research and development" P1. "This call tries to take entrepreneurs on a journey […] that includes a whole stage of mentoring, consulting, seed capital and acceleration" P2."There is also a call to develop new products, prototypes and […] new technologies" P6.
5. Value networks	Platforms, webs of relationships and value networks for collaborative innovation	"This is a global platform that takes a company, with the potential to grow exponentially, and connects it with contacts worldwide to make it happen" P3. "The platform […] connects you with people more or less close to you or that works the same as you" P13."a network where we all participate, we connect, we define ourselves and with that definition one begins to look for those companies that do what I need." P14

Table 13

Codes for "Formal institutions influencing the IP of an RIS" (continuation)

Codes	Explanation	Verbatims from interviews
6. Education and training systems	Education, training and learning environments and systems, were knowledge is not necessarily related to an specific innovation project	"For example they tell me that they would not be interested in a master, because they have already done the Ruta N course, they already know about innovation" P16."Several programs, of innovation management, of creation of centers for science and technology in the companies, topics related to talent development" P26." Those spaces of training generated from the ANDI […] were a knowledge engine in the subject" P28.
7. Mechanisms for knowledge transfer	Platforms and environments designed for knowledge and technology transfer related to specific innovation projects	"The incorporation of exponential technologies in the ecosystem […] rather than investing [in the technology] it is about bringing knowledge" P3. "to bring people, to generate capabilities […] providing consultants, advisors to their programs" P12."So what we did was to start bringing to the city knowledge of nanotechnology, topics of optics, issues that had to do with biotechnology" P13.
8. University–industry formal alliances	Alliances between academic entities and firms on RD&I projects	"We have developed an interesting work with the universities […] with the same model of putting a challenge that they develop" P6. "Although it is private [organization], it has participation of universities and helps to outline the business of biodiversity and biotechnology" P7. "With universities we have a lot of contact […] with their research groups, with associated professors that support us with methodologies" P11.
9. Statutes and organizational rules	Structure, rules and statutes of the organizations, that encourage or discourage the innovation activity	"When you are in an industrial world there are hierarchies, then many people do not realize the change and want to continue applying hierarchies in formal institutions and that is not good" P10. "Company's organizational structure normally do not give innovation enough decision power" P15. "Organizational structures and regulations are not keeping pace with changes in the environment" P22.
10. Innovation indicators and metrics	Organizational and systemic innovation indicators and metrics	"We have numerical city indicators, we measure them independently, there are third organizations that measure them, we have traceability of these indicators for several years" P10. "We have to be governed by several symmetric indicators, including technology-based entrepreneurs, new patents, new products, services" P12. "And they are measuring us with indicators that are not those of the subject, as how many people impacted, the number of the population, the GDP growth…" P17.

Table 13

Codes for "Formal institutions influencing the IP of an RIS" (continuation)

Codes	Explanation	Verbatims from interviews
11. Government RD&I initiatives	Initiatives for RD&I hold solely by governmental organizations	"Another great [governmental] program is the observatory, it is updating the system permanently to inform people or universities where research of the future is, to the companies where the business models are, to the citizens, how the world is moving and how they can access this technology to improve their quality of life" P13. "And also those surpluses of 'EPM' that can be invested in science ... in projects that do not exist in other cities, allowing us to continue carrying out research projects" P1. "The centers of excellence are an initiative […] of Colciencias to articulate the thematic capacities of different organizations to generate high-level research products but with capacity for rapid transfer to the environment" P17.
12. Industry RD&I initiatives	Initiatives for RD&I hold solely by private companies and firms	"Nutresa as a big multi-Latin performs great, it is innovating, it is exporting, as can be seen in the book that the former president published recently" P7. "Camacol is a giant support and with Camacol we converse every week about this topic, about how the construction is changing and we can do for the construction greater margins" P11. "What we are seeing is that little private capital is moving towards innovation projects" P12.
13. Academic RD&I initiatives	Initiatives for RD&I hold solely by universities and academic research groups	"Innovation projects that we have in partnership with the other universities" P1. "[The University] EAFIT also seems to me as a benchmark in innovation for all the projects that they are advancing" P4. "There are universities that are working on innovation at the regional level" P18. "The centers of technological development in the universities" P29.
14. Innovation and knowledge management	Organizational process to acquire, assimilate, distribute, integrate, share, retrieve and reuse internal and external knowledge for innovation processes	"These societies are generating knowledge and trying to transform that knowledge into well-being for that society" P10. "With allies we design the strategy and identify the need or relevance of patenting, or protect a brand, or protect a knowledge, or make an intellectual property agreement" P22. "help companies to identify innovation challenges with the objective of taking this information to universities so they know what is happening in the market and develop knowledge that translates into technologies that are relevant to those needs" P24.

Table 13

Codes for "Formal institutions influencing the IP of an RIS" (continuation)

Codes	Explanation	Verbatims from interviews
15. Public Investment on the institutional framework	Governmental investment to sustain innovation policies, plans and all the formal institutions related to the well-functioning of the RIS	"The technology plan also has the perspective of securing resources, which is 7% of the ordinary royalties that EPM leaves to the city, which is fundamental" P13. "[With public investment] organizations have been created, they have been formalized, and resources have been allocated" P22. "It was invested enough in the eighties, in technology parks; today it is advancing towards living labs. This is crucial because this is what connects the citizenship" P27
16. University–industry–government formal alliances	Alliances between governmental, academic entities and firms on RD&I projects	"We [as an industry firm] have also had the opportunity to do some developments and some work with Colciencias [public entity] and also through universities" P13. "They love that kind of projects at the level of university–industry–government " P11."At EPM [public entity] we are teaming up with a local university and with two local private companies" P27.
17. Government-industry formal alliances	Alliances between governmental entities and firms on RD&I projects	"Then we have maintained an alliance with EPM [...] to be able to bring the [electric] vehicles and provide the services because not only is it to bring vehicles but also the supply of energy they need" P5. "We have had agreements of different types for developments, for validations, etcetera, or for bets in the development of a specific product, with Ruta N" P6. "With Innpulsa and Ruta N, which were the ones that I mentioned at the beginning, we work hand in hand" P12.

The categories related to the formal institutions that emerged from data, were verified and triangulated with results of other studies and with theories related to the subject, in order to enlarge the results of empirical research and enlarge some important issues. In the article written by Qu et al. (2017) it was possible to find a broad categorization of the formal institutions for innovation. They mentioned that the important promoting factors of regional IP are the efficiency and effectiveness of: (a) financial institutions, (b) taxation institutions, (c) educational institutions, (d) regional legal institutions, and (e) government support. The present study allowed identifying 17 important formal institutions for the IP of the RIS.

The formal institution most frequently identified by interviewees in the RIS is the investment for incubation and acceleration. Various authors have explored and stressed the importance of investment for innovation; while for example Pierrakis and Saridakis (2017) focused on the positive effect of joint investments, which includes public and private capital to support innovation processes, Keune (2001) emphasized on the importance of foreign investment for regional innovation. Zook (2004) said that the relevance of venture capital versus publicly backed funds in organizational innovation projects is that venture capitalists have contact networks in a geographic area or an industry and can often better assess the quality of an investments opportunity. Cooke (2001) also said that venture capital funds are an essential factor in innovation systems, as one governmental sector informant reflected:

> If you want to get fully into the new era you have to stimulate [innovation] to be generated… then there are the venture capitals, those are the angel investors, etcetera. So how do you encourage that to happen? Already in Medellin, there exist an institutionality of intelligent capital network that has those capacities (P10, 10:17).

Meanwhile, according Pierrakis and Saridakis (2017), publicly backed VC funds play a greater role in mobilizing the RIS by supporting academia, research institutes, and organizations.

In relation to laws and regulations, it has long been recognized that in systems of innovation firms interact with other organizations in the context of existing laws, rules and regulations (Edquist, 2013). According to Asheim and Coenen (2005), the innovation system is a result of policy intervention to increase innovation capacity, but it is important to distinguish between the specific laws operating in a system and the innovation policies and plans. Laws and regulations may be the result of strategic plans and policies, which explain and consider the set of strategies and actions needed to achieve the proposed objectives. Laws

and regulations are not always observe to exert a positive effect over IP, as the following

exchange at an interview suggests:

> We look at the legal part, I am not an expert in this, but all this type of increases that
>
> there have been in the taxes and fees that have to be paid now, are reflected in the fact
>
> that there is as a medium-term decrease in that investment. If this continues to
>
> increase then I can see that as something negative (P6, 6:27)

According to Lee and Law (2017) the innovation policies and plans as well as the

laws and regulations are intended to provide support for new businesses, reduce the risk,

safeguard the needs of innovators, and also facilitate the access to assets and financing, as for

example grants and government-sponsored programs. The category that includes government

as well as non-government sponsored programs was named "calls for innovation projects".

In the relation to the category named as "value networks", this type of institution has

been identified as crucial for innovation by various authors and for interviewees. For

example, Iammarino (2005) included the following institutions when analyzing RISs: "inter-

organisation networks, financial and legal institutions, technical agencies and research

infrastructures, education and training systems, governance structures, innovation policies,

etc." (p. 499). Note that all institutions mentioned by Iammarino (2005) resulted significant

for the subjects included in the present study, what also reaffirms the pertinence of the results

obtained, for example:

> What else has had an impact there so very, very, very notable? Everything that has to
>
> do with networks. The Market Access Network, the Smart Capital Network, the
>
> Business Development Centers… (P13, 13:31)

On the other hand, it is important to distinguish between consolidated and well

structured value networks, which are considered a type of formal institution, and the social

networks as a component of social capital, that enable synchronization and collaboration for

collective advantage (Lee & Law 2017), which are included and later analyzed within the informal institutions domain.

Lambooy (2005) said that formal networks are a key coordinating mechanism of information flows and Santamarıa (2007) found a great positive impact on the IP from collaborative networks, but on the contrary, Smith and Waters (2011) found the networks to be a result of coordination rather than a key coordinating function. In addition, Zeng et al. (2010) stressed that policy makers have create effective institutional arrangements and policies to facilitate local cooperation, for example a financial subsidy for firms engaged in collaborative innovation projects, and form a stable platform for networking and cooperation among the different actors.

In the next category, which includes the aspects, related to the education and training systems, according to Berger and Diez (2008), deficiencies in important factors for the innovation systems, as foreign language proficiency, interdisciplinary capabilities and problem solving can be attributed to an obsolete education system. On the other hand Varsakelis (2006) examined the effect of the existence of a national system of institutions and organizations on innovation activity finding that the higher the investment in the quality of education institutions, the higher the output of innovation activity of the system. In the same line Jiménez et al. (2015) found that the level of education of the population is strongly positive related to innovation absorption and regional economic growth, and for the case Rodríguez-Pose and Comptour (2013) they found it to be directly related with 'innovation prone' territories.

At this point, it is important to differentiate between the education system and the mechanisms for knowledge transfer, which is the next most frequently mentioned formal institution. The education system helps the acquisition of more general skills, values and knowledge, including those that may be not use in any specific project; while the knowledge

transfer occurs between organizations, groups or individuals that have a cognitive understanding, have the ability to apply the knowledge and apply the knowledge (Paulin & Suneson, 2015). This means that knowledge transfer refers to the act of transferring knowledge or technology useful to a specific endeavor or as a solution for a certain problem.

The role of knowledge transfer mechanisms from universities is different depending on the predominant nature of the knowledge used in one or another industry. Industries located in sectors such as biomedicine, pharmaceuticals, electronics, etc., usually use explicit knowledge of scientific nature, as well as codified R&D bases. Other sectors such as food, clothing, automobiles, etc., make use of diverse types of knowledge, including tacit knowledge, and synthetic knowledge (Fernández-Esquinas et al., 2016).

In accordance with findings of Fernández-Esquinas et al. (2016), in the study was observed that university-industry alliances are important, but some of them are still focused on supporting activities as procedural services, access to special instruments, technical consulting, education and applied research, but not so much in basic research and radical innovation projects. The following quote from a private sector informant illustrate this issue:

> Well, we have developed an interesting job with universities, but not a platform as such... Let say that it has the same connotation of these open innovation platforms where companies put a challenge for someone to solve and pay them, let's say we made that same model, not in a virtual way, but directly with the universities (P6, 6:26).

On the other hand Kaufmann and Tödtling (2001) emphasized on the role of scientific knowledge as the most valuable contribution of universities and academic research centers to innovating companies, recognizing that university-industry cooperation can also "trigger the change of traditional perspectives, decision rules, and objectives of firms without actually adding knowledge" (p. 798). From different perspective, Morandi (2013) analyzed the

benefits derived from industry-university joint research projects, understanding the reciprocal relation of R&D cooperation and the need of mutual adjustment practices.

Although, the relationship between the private firms and the academic entities is often related to knowledge transfer (Abreu & Grinevich 2013; Corral de Zubielqui, Seet, & Lindsay, 2015; Fernandez et al., 2016), the decision when analyzing data in the present study was to discriminate amongst "Mechanisms for knowledge transfer" and "University–industry formal alliances", as some interviewees mentioned alliances and projects between these two actors with broader scopes, as for example:

> I think BIOinTropic business model is much clearer, so even though it is a private organization, it has alliances with several universities and what it does is to help outline the business of biodiversity and biotechnology in the country (P25, 25:29).

For the case of some university–industry alliances for innovation projects, informants expressed that both parties contribute tangible and intangible resources, as equals, to create and apply new knowledge. Different actors mentioned the relevance of private parties: "so if you go to Argos [private firm], there you will find PhDs" (P25, 25:20), "Argos in Colombia is a benchmark [for innovation] and Argos has a strong alliance with EAFIT" (P4, 4:35). Additionally, not only academic partners do the knowledge transfer, as a range of different types of actors maybe involved is this processes (e.g. private consultants, related private firms, etc.).

George, Zahra, and Wood (2002) found that firms with university linkages had lower research and R&D expenses and presented higher levels of innovative output, while Iammarino et al. (2013) concluded that cooperation with universities was statistically influenced in a positive way by the geographical immediacy of the identified parties.

The next most mentioned formal institution affecting IP, is the statutes and organizational rules. According to Ganter and Hecker (2014), the organizational structure is a

determinant of organizational innovation. It is very important to note that there is a distinction between two levels of research: innovation management and innovation systems. Innovation management is related to the specific techniques and tools to manage innovation process within a particular business environment (Goffin & Mitchell, 2016), which includes organizational structures and statutes, but when analyzing data, this variable was consider being an important institutional factor affecting IP at the systemic level:

> That [organizational statutes] allows the subject of innovation to remain within our culture and we are going to do it constantly. We are committed to do it as an organized and methodological process (P1, 1:46).

More than 60% of participants mentioned the organizational statutes as important for the systemic innovation and some remarked the need to impulse and encourage less hierarchical and flexible organizational structures, among the organizations participating in the RIS. One interviewed said:

> We still have problems of hierarchy, as we are moving into a new era, the new era is more egalitarian, […] then many people do not realize the change and want to continue applying hierarchies in formal institutions and that is not right, this is determinant so that all citizens feel in the same position and feel that everyone can innovate (P10, 10:30).

The following formal institution identified is related to the standardized formal innovation indicators and metrics, and all the sets of metrics associated with the OECD, the Oslo Manual, and Frascati Manual (Eurostat, 2012; OECD 2005; 2007; 2011; 2015) are supported on the premise that indicators and standardized periodical measurement of innovation are critical for diagnosis and efficient management of innovation. This is illustrated by the following comment: "When we have that measurement, the measurement of what capacity we have, it facilitates the innovation process" (P14, 14:59).

It is noticeable that the next three categories which are "Government RD&I initiatives", "Industry RD&I initiatives" and "Academic RD&I initiatives", appear next to each other as they have almost the same proportion of mentions among the respondents; less than a third of interviewees mentioned them. It is possible to observe how those specific initiatives appear to be at the bottom of the list, which has two ways of analysis. The first perspective points out the fact that the institutions at the top of the list are the crucial conditions for the innovation to occur, so informants place more importance on the resources available and favorable conditions for innovation than they do on the programs and initiatives that are already functioning. This is logic if we consider that people easily perceive how better conditions may affect IP levels, while it is not so easy to understand how innovation carried out by other organizations may affect their own innovative activity and performance.

The second standpoint, starts for the possibility of visualizing the three categories as one big category and summing up all the mentions from interviewees, what will position the broad category at the fourth position of the list. In this second scenario, formal RD&I initiatives will recover relevance, but only when they are analyzed indiscriminately.

The decision to keep the three categories apart was based on the following aspects: (a) it is important to represent the institutional participation of the three formal actors within the quadruple helix model, (b) the existent literature has explored the role of those three actors separately, and (c) for later analyses about the institutional impact on IP, and propositions for further research, it is important to rely on this kind of precision.

For example, Criado, Sandoval-Almazan, & Gil-Garcia (2013), Riboldazzi (2017), and Morabito (2015) focused on innovation of public sector organizations and on regional governance innovations, Olaeta (2017), Olokundun et al. (2018), and Yeo, B. (2018) focused on the role of university initiatives for innovation at different levels. Finally, a large number of authors have focused on studying cases on innovation initiatives at the firm level and their

impact on innovation systems (e.g. Bartnik, Wilhelm, & Fujimoto, 2018; Hanson, 2018; Lockwood et al., 2017; Papaioannou et al., 2018; Watkins et al., 2015).

Next in the list, the participants mentioned the importance of innovation and knowledge management for the IP of the RIS. Knowledge management is defined as the association, formation, distribution and growth of knowledge in the organization to gain and sustain competitive advantage (Lin, 2014). Various authors coincide that knowledge management has an impact on innovation not only at the organizational level (Liao et al., 2010; Kambiz et al., 2018; Väyrynen, Helander, & Vasell, 2017), but also at a systemic level (Chu et al., 2014; HaiYan & Feng, 2007; Vines, Jones, & McCarthy, 2015). One participant from the academic helix pointed out that even though innovation process and knowledge management are related they are not the same: "That for me is a negative thing, because I think there is no clarity. One thing is the process of innovation and another is the management of innovation" (P16, 16:89).

One of the institutions mentioned by less interviewees, but not less important, is the public investment to sustain innovation policies, plans and all the governmental institutions related to the well functioning of the RIS. This institution should not be confused with venture and resources directly intended to support innovation projects, as the investment in the institutional infrastructure operates at a more macro level and is closely related with institutional change. As said by Tang (2017), institutional change "is essentially a process of turning ideas (out of the pool of many) into institutions" (p. 8) and "institutions do matter for human welfare and institutional change is a major driving force of social change" (p. 9). A government informant explained:

> The royalty plan is also recently constituted as a formal institution, but it is affecting as it is decreasing more and more the amount of royalties destined to innovation and this is creating a lack of capital to invest in this type of projects (P22, 22:59).

The last two formal institutions in the list are the "university–industry–government formal alliances" and the "government -industry formal alliances". Even though, the alliances between university, industry and government, also known as the triple helix (Etzkowitz & Leydesdorff, 1997), are one of the most discussed issues in the existent literature about RISs (e.g. Etzkowitz & Dzisah, 2008; Ford, O'Neal, & Sullivan, 2010; Leydesdorff & Meyer, 2006; Park & Leydesdorff, 2010; Sutz, 2000) most respondents did not directly mention projects or formal alliances that clearly include the three types of actors. This could be due to the difference between the theory and the practice, as achieving and managing collaboration on formal agreements between two actors is often easier than coordinating agreements of three or more parties. As one respondent from the university said:

> Let say that our culture is still distrustful. Then I as an investor will not get into that [formal agreement with an academic partner]; he is no going to think of a professor of 'EAFIT', like - I am going to get into that platform to see what I find... Let me see … mmm… no… that does not happen (P7, 7:55).

Finally, government and industry formal alliances, was the type of institutions least mentioned; just five interviewees talked about this kind of formal alliances, and in accordance few articles were found in academic journals, addressing specifically government-industry alliances. According to Wallsten (2000), although there is a positive relation between the government-industry R&D programs and the level of R&D, it is not possible to determine causality. The author also pointed that in this kind of projects the "social returns to private R&D are often higher than the private returns, and some research projects would benefit society but would be privately unprofitable" (p. 83).

Jinchao, Guoquan, and Yuhuan (2011), found that government-industry research integration played an important role in low-carbon innovation and in regional innovation system. For the articles published, in many cases the authors placed special importance in the

financial function of the government when analyzing government-industry relations, but comments from participants in the present study suggest that governmental organizations are nowadays contributing in projects with different kinds of resources rather than money. The following participant illustrated this shift:

> With Tecnnova, there was also like a project for the development of a patent, and for that patent, it was basically developing a business model to sell the patent. Then, as the counterpart, Tecnnova did it as an accompaniment to the development of that model, and they did it as a coaching type, advising on that development, and finally validating if that model was viable for what we wanted (P6, 6:22).

Aryanto and Fransiska (2012), who assessed different roles of government cooperation for IP in their study, also back this vision of a governmental function beyond financing, remarking a more active role of government in the face of different tasks and needs within the innovation process.

Informal institutions influencing the IP of an RIS.

In the fourth theme that corresponds to the "Informal institutions influencing the IP of an RIS" 31 codes were defined after data processing and analysis (see Table 14). This section comprises the analysis of informal institutions that affect the innovation processes and the results of the system, also classified in a broader category as attitudes, behaviors, capabilities, and competences.

At this stage, the initial 57 emic codes that emerged from the data collected were grouped according to the type of informal institution they belong to, for an easy and meaningful analysis and presentation. Seeking theoretical congruence and reliability, the process of categorization was also supported on etic categories found in diverse scientific literature on the subject. The complete initial emic coding before grouping, is shown in Appendix H.

Table 14

Codes for "Informal institutions influencing the IP of an RIS"

Codes	Explanation	Verbatims from interviews
1. Innovation supportive culture	The level of support that general public shows towards innovation activities and creative thinking	"The vocation that the region has, the willingness to innovate, well ... there is an innovative culture" P1. "This is more about culture, I believe that one can make innovation without the need of laws, this is more of an attitude that someone behind pushing me to achieve it" P11.
2. Risk taking	Described as the personal and organizational willingness to assume risk of uncertainties in the innovative process	"They are less afraid of taking risks, I'm talking about younger generations, people who are suddenly less afraid of taking risks and being out of the ordinary, and investing time in different and new developments" P6. "There is still a fear of letting go, companies find it hard to change, it is difficult to take risks even when the need to make changes has already been detected, we have resistance to change and usually in companies there is a fear of letting go, taking risks and face the unknown" P22.
3. Human capital	Skills, education, and labour attributes of the population which influence the productive capacity	"It starts with the human resource, I do not know if it is also cliché or something romantic but obviously the region has a very cool factor there that makes you think 5 steps ahead of the rest" P2. "The preparation of all, entrepreneurs, universities, investors, managers, government, that's something, preparation and training "P12.
4. Regional identity	Described as the identity that makes people feel part of the society, its culture and traditions, particularly delineated by the region of the RIS	"We still have very conservative roots; we have a family that were people who grew up in towns, with very conservative ideas of how to face life, still afraid to take on challenges" P6. "Hopefully we can take away the switch that we are so regionalist and realize that there is more things, because we are very close to ourselves and that has made us take care of Medellin, reason why it is so beautiful but this is not good at issues of innovation and market" P12.
5. Market orientation	Described as the a focus on the tangible results from the ideas or projects executed	"The pressure to show results, does not give space to the trial, the innovation has to go through uncertainty, it has to go through different moments where the results are not obtained, but we must go back and make the turn and again look for it" P19 . "The declaration of victory [of innovations] is that they leave this protected world to impact the businesses and some are already beginning to do so" P26.

Table 14

Codes for "Informal institutions influencing the IP of an RIS" (continuation)

Codes	Explanation	Verbatims from interviews
6. Egocentrism	Described as snobbery, stubbornness, and high level of demand (personal and from others)	"The big businessmen, I think they still have a pride and a gigantic ego, and believe that because they have resources they can do everything, everything, but they do not understand the dynamism, the flexibility, the speed, the agility; the people, how small companies can contribute to achieve operational efficiencies" P2. "The difficulty of execution that we have and the management in those hierarchical structures where we have to handle many egos" P18.
7. Entrepreneurial orientation	Described as an entrepreneurial culture but also as an ability to execute ideas.	"An entrepreneurial culture that has been transformed into an innovative culture" P1. "Definitely the factor of that entrepreneurial culture, that helps a lot" P12. "The character of the entrepreneurial culture and of finding solutions and finding answers as well" P17.
8. Social innovation orientation	Described as the willingness to pursue innovations that represent solutions to social and environmental concerns	"That is why it is so important to involve the citizen because it does not matter how many intelligent people, engineers, scientists, entrepreneurs understand if the ordinary person does not get involved in that change in any way it is very difficult for society to transform" P10. "For us innovation not only translates into knowledge transfer with a commercial purpose, it translates into the welfare of the population" P23.
9. Interaction and collaboration	Defined as the articulation of the actors from the quadruple helix to cooperate along the innovation processes	"Today the world is different, today they are all interacting with the primary research centers, with the first companies, with the best groups worldwide" P9. "We are still very close, and it is not a collaborative attitude of innovation, I continue to see rivalry and if I achieve a savings it is mine" P11. "We almost finish doing it internally [innovation] without teaming with anyone" P28.
10. Time orientation	Defined as the preference toward past, present, or future thinking, which directs decision making towards the long, middle, or short term	"There are some innovation projects that are short term, horizon 1, for a year or 6 months or 2 months and there are some quick changes that will allow you to win early, but there are more divergent innovation projects that require patience, and our managers are usually very oriented to projects horizon 1" P15. "The short term […] they think it is better to invest in an arepas' factory because it gives you money quickly, than in a technology company that gives you money in two years. The short term I think it is the most negative part of the system and the culture "P20

Table 14

Codes for "Informal institutions influencing the IP of an RIS" (continuation)

Codes	Explanation	Verbatims from interviews
11. Innovation knowledge and skills	Defined as the specific skills to undertake innovation	"I think that we still, I include myself, we do not understand well what innovation means, I think we have an absolutely distorted concept of what it means to innovate, people believe, or we as a society believe that innovation means simply creating something new" P2. "There is no formal education for the concept of innovation" P16.
12. Civic associations	Are the social movements related to innovation topics	"ECSIM is a non-profit foundation that consists of a group of PhDs experts in these issues and we meet to work together, it is a community" P9. "There is a series of social groups which are very strong in the city […] they already make an important social fabric, so I think that they are among other institutions ... small but they have a very large impact" P10.
13. Global vision	Described as the orientation of the actors of the RIS to interact with the rest of the world	"Youth can fly easier to the world and know other opportunities… in our time only the upper class could have these opportunities" P18. "What you have to do is to make new ventures and ventures in things that do not exist, in sectors that do not currently exist and that can be inserted into the global economy, I think that's what's missing" P20.
14. Bonding social capital	Described as the social cohesion and the relational skills	"A clear definition is from the point of empathy, that is, if I can open up to you and I can make another person open up, from that point opportunities can flourish" P11. "And it is a very connected city, which is an advantage to innovate, people are very connected to each other, and that is a fundamental factor for innovation, the connection of the people" P13.
15. Honesty	Described as the transparency and goodwill at a corporate and personal level	"The university is convinced that the company does not want to recognize intellectual property and wants to keep the whole business and the company thinks exactly the same about the university" P1. "All this control must be done, if not, they steal everything" P13. "That has been encouraging advantageous and opportunistic behavior" P26.
16. Trust	Described as the confidence in the personal or organizational performance, ethics and integrity of the other actors of the RIS	"It's as if private organizations do not yet have confidence in this ecosystem to bet on it" P7. "Likewise, in an innovation ecosystem what stands out most is culture or, for example, issues of trust" P10. "Then the problem begins: sign the confidentiality agreement, everything we speak is confidential and if not, ten years of jail for you" P17.

Table 14

Codes for "Informal institutions influencing the IP of an RIS" (continuation)

Codes	Explanation	Verbatims from interviews
17. Creativity and resourcefulness	Resourcefulness was defined as about creatively optimizing the resources one have to work with	"We are not taking advantage of all these spaces that are being generated around innovation" P5. "It is more cultural, that is, the culture of Antioquia's recursion, if we are speaking from the cultural point of view of resourcefulness, the push" P23. "That indigenous malice that develop the creativity also leads us to generate innovation" P25.
18. Open innovation	Is an open approach to innovation, that allows a dynamic external cooperation from different actors	"I want to change the world, and if I open the patents of an electric car, that means that, the competitors are going to start making electric cars, but I'm one step further, I'm not going to worry about close my [knowledge]" Q11. "Yes, it is a platform for citizens to help us innovate, then, to show us solutions to specific problems [...] what it does is to involve citizens in the solution of problems" P25.
19. Ambition	Described as the desire to achieve difficult goals, success, power, or wealth	"Something positive is the *paisa's* ambition to conquer things" P13. "From the informal side [...], let's say that we are in a society where power and money are more important" P16. "I believe that we, the private firms, always have the pesos in our heads" P28.
20. Resilience	As the capacity to cope with difficulties, stress and hardship when pursuing a goal, being able to recover after any failure	"Go ahead with it and be easy … if we fall down here we get up again and we continue doing it" P19. "Resilience … the *paisas* are an example of resilience, of going from a city back to nothing to become the most innovative city in the world" P21
21. Indulgence	Defined as an orientation towards the compulsory gratification of desires avoiding conflict or complexity	"But at the same time they are reluctant to change [...] it seems that the change is important if the idea comes from them, if not, not" P16. "In everything that implies effort, and dedication of time without results, I do not see much interest" P16. "I'm very scared by the illusion of easy progress without doing the whole task" P26.
22. Knowledge Democratization	The equal access to knowledge for all actors of the RIS	"We want this issue to become transversal to the entire organization, as they define it, is to democratize knowledge" P4." In the age of knowledge, this is what makes the difference; you cannot let a subset of society's elite to have the knowledge and hope that they will help others" P10."Google! There you will find everything you want on the subject [...] you can find everything you want" P25.

Table 14

Codes for "Informal institutions influencing the IP of an RIS" (continuation)

Codes	Explanation	Verbatims from interviews
23. Perseverance	The effort required to do something and keep doing it until the achievement of the expected results	"Because here, there are people who have initiative, a lot, but they have to fight against the sea, the storm… against everything to be able to develop well" P2. "The idea is a bit, but the other bit is to pedal, because many ideas remain in ideas, precisely because there is no attitude to take them forward" P11. "When we are clinging and committed, then we are stubborn, and for innovation you have to cling to roots and be stubborn" P25.
24. Work team effectiveness	Defined as the core competence to work in teams, attaining levels of collaboration and synergies that allow to achieve greater IP than by working individually	"The new era is more egalitarian allowing high-performance teams" P10. "Some build the teams with the wrong people, and adequate behaviors are not generated for the company to innovate." P15 "When we are going to make it practical, pass from idea to something, we have to share and generate work teams, because I alone cannot solve a big problem, and for real innovation you need interdisciplinary" P17.
25. Optimism	Defined as the belief that the final outcome of some specific task, project or current situation will be desirable and favourable	"Let's say that, at a cultural level, at the regional level we are still a region of optimistic people, so I think that in some way this influences the future as more hopeful and people want to invest more" P6. "We tend to see the black dot on the white sheet instead of seeing everything. It is a very bad condition to highlight the negative "P21.
26. Commitment	The engagement to assume and fulfil an external obligation or something that people believe in	"Then that lack of commitment [of young people] may be because they are people who do not have responsibilities" P6. "We fail to comply, we are procrastinators" P18. "The political entanglement of laws and so on, makes that a person may be in jail or sanctioned, for not acting or acting in a certain way, and that prevents people to commit" P25 .
27. Tolerance for failure	Described as the ability to deal with failure and overcome frustration	"[our culture] punishes very strongly who fails, does not accompany people as part of that learning project, then it is hard for us to try, to risk ourselves" P10. "With that condemnation to failure also fear that then I get kicked out for that ... and then I rather say nothing, better not participate" P17. "Another is the punishment of error that kills innovation completely" P18.
28. Leadership	Described as the capacity to exercise social influence, to maximize results for the achieving innovations or related goals	"It is really the leader and the different ways of seeing an organization" P11. "The existence of business leaders who work for all these issues" P24. "But we lack the leadership that allows groups of people or individuals to connect with an ideal, a dream, and that is the leader that in a very authentic way, indicate the direction" P25.

Table 14

Codes for "Informal institutions influencing the IP of an RIS" (continuation)

Codes	Explanation	Verbatims from interviews
29. RIS learning capacity	Defined as the capacity of RIS's actors and institutions to evolve according to changing circumstances and contexts	"But as a system that learns, it is not a system that has all the lessons defined from the beginning ... that would be a static system in which everyone knows their laws and principles… it is a system that interacts and interactions generate learning "P23. "We are thinking this in this way, then we need the institutions [of the system] to regulate what we are thinking" P18.
30. Religiosity	Described as the amount of importance of religious activity, dedication and beliefs at a personal or collective level	"We have religious obstacles" P2. "For me, the issue of religion is also a very important factor in that development. Because somehow, I feel, that a country with a high percentage of religious people, is afraid to look at different things "P6."Other religious issues affect, as the progress is slowed and matters are stuck, and then many say If God wants to…"P28.
31. Language proficiency	An appropriate level of English as a requisite to communicate with external sources for learning and networking	"The issue of the language … to learn a second language then, or a third or fourth or fifth" P18. "The other thing that does not help is the lack of English of the people in this city, it's scary" P26.

As already mentioned, the categories representing informal institutions, which emerged from data, were verified and triangulated with existent literature from various authors and results of previous studies, in order to reinforce findings and conclusions. This section includes the information found when performing the academic literature review for each variable found within the informal institutions affecting the IP of an RIS. Only for one variable, which was egocentrism, no articles were found to date in academic databases relating it to innovation in any way, nor exploring its role for IP or in innovation systems.

The informal institution affecting the IP of the RIS most frequently mentioned by the interviewees was the innovation supportive culture. Innovation culture are "the values, beliefs, assumptions, and symbols in an entrepreneurial venture that facilitate activities including, but not limited to, the pursuit of novel products, services, and/or production

processes" (Michaelis, Aladin, & Pollack, 2018, p. 117). In their study Michaelis et al. (2018) found that innovation culture construct is a consistent predictor of innovation performance and Crescenzi and Percoco (2012) stated that "good culture is a factor facilitating the movement of goods and people both within and between regions because of the reduction in transaction" (p. 3). Therefore, innovation culture is crucial for IP, as the following quote illustrates:

> I would believe that culture has also led [the transformation] as we have been pioneers in many things and continue to be pioneers, because that also drives the innovation process … I think this is already rooted in the region (P28, 28:14).

> In addition, the institutional dimension related to the innovative culture, as the support that society provides to the innovation processes and to innovators, has great importance for the IP to the extent that it affects the willingness to support and participate in innovation activities, but still with its importance the studies analyzing this institution and how it works in society are still very little (Lee & Law, 2017).

The second institution in the list is the risk taking. The society's disposition to assume risks and face uncertainty is significantly related with innovative behavior (Crescenzi & Percoco, 2012) and according to Dess and Lumpkin (2005); risk taking is also related with innovativeness, pro-activeness and entrepreneurial orientation. The risk-taking level, is one the factors that makes any territory either innovation prone or innovation averse (Rodríguez-Pose, & Comptour, 2013). As one respondent asserted:

> There are other cultures that depend a lot on a public sector or cultures where it is not well seen to take risks, here it is very well seen and I believe that it favors that more people are throwing themselves into the [innovation] system (P20, 20:15)

> The informal institution of human capital, refers to the ''capability that finds its source from knowledge, skills, workers diversity, training, absorptive knowledge and all

other forms of knowledge driver capacities" (Vancauteren, 2018, p. 911) and various authors affirmed the importance of human capital for innovation (e.g. Crescenzi, Gagliardi, & Percoco, 2013; Dakhli & De Clercq, 2004; Lee & Law, 2016; Rodríguez-Pose & Comptour, 2013). It is important to observe that knowledge capabilities, in human capital, denote profounder attributes, even culturally rooted, which may not be evident or directly measurable, as for example one interviewee said: "[in the system] we need more people who know how to do things, and fewer people who know how to plan, I think that is what is needed" (P20, 20:30).

Regional identity was also one of the most mentioned informal institutions influencing the IP of the RIS. Cooke et al. (1998) included the regional identity as variable of interest when they first formally defined the concept of RIS. This institution affects the social integration and cohesiveness, shaping collective action and therefore becoming an important element for regional development (Paasi, 2009). Other articles also presented regional identity as an innovation resource and not as a variable with a negative effect (e.g. Cabras & Bamforth, 2016; De Massis et al., 2016; Gorgoglione, Petruzzelli, & Panniello, 2018. According to Raagmaa (2002), regional identity affects people's disposition to achieve common goals, raising their personal activity, securing public participation in planning, and influencing the regional development.

Market Orientation refers to a "marketing strategy in which a firm places the customer's needs and wants at the center of its tenets and tactics, and focuses on learning about its customers, competitors, and environment" (Song, Wei, & Wang, 2015, p. 319). As one private sector informant explained, "It seems that we are staying more in inventions than in innovations. Innovation makes sense when there is a market that pays for that, if there is no market there is no innovation" (P7, 7:59).

According to Ozkaya et al. (2015), market orientation and its positive effects on innovation and performance have been studied in detail, and for Edquist, (2013) the emphasis on demand is a determinant of innovation, not only from the point of view of organizations but also from innovation policy instruments that have an effect on the diffusion of innovation.

Entrepreneurial orientation has been found to be positive related to innovation and it refers to the degree to which society admires and encourages entrepreneurial activity, so entrepreneurs may not be inspired only by monetary incentives but driven by social perceptions and personality (Lee & Law, 2017). This is in line with what was found in the information collected: "It seems to me that something that favors innovation in our region is that and the character of the entrepreneurial culture and of finding solutions and finding answers as well" (P17, 17:29).

Social innovation orientation is an important factor to consider when studying innovation systems (Olaeta, 2017). Social innovation includes "activities and services that are motivated by the goal of meeting a social need and that are predominantly diffused through organisations whose primary purposes are social" (Mulgan, 2006, p. 146). In addition, according to Rao-Nicholson, Vorley, and Khan (2017) the capabilities and learning process associated with social innovation, not only facilitate a social reform, but help in the development, redesigning and improvement of innovation systems, leading to value creation in emerging economies.

The next institution, defined as interaction and collaboration, is related to the willingness of people to interact and cooperate with different partners, and according to Pekkarinen and Harmaakorpi (2006) collaboration lead to an increase productivity by decreasing transaction costs, correcting market failures and decreasing risks. Although collaboration has been said to increase the IP due to the reasons previously mentioned and the

amount and variety of knowledge shared, it certainly implies considerable risks of opportunistic behavior (Nieto & Santamarıa, 2007). As remarked by one subject:

> What happens is that the people in this city got used to the easy money and everything is already there; there is an expectation for super-fast things, and that has been encouraging advantageous and opportunistic behaviors that in the short term undermine the possibility of collaborating (P26, 26:19).

It is important to distinguish the formal version and the informal version of this variable to avoid confusion. While in the formal institutions, collaboration is reflected as formal alliances, which became institutionalized by a document, contract or agreement with specific conditions and rules; in the informal version, it is related to a behavioral factor that traduces into a personal disposition to interact and cooperate with others. Rao-Nicholson et al. (2017) remarked the importance of collaboration in socially innovative enterprises and social innovation, while at the same time this creates capacities to change the institutional environment through new collaborative ways of working.

Time orientation, is an institution closely related with short-term vs long-term orientation construct introduced by Hofstede (2001) as one of the most relevant cultural variables studied by the author, and was mentioned as important for IP by more than the half of interviewees. This informal institution or cultural trait was found to be mentioned in a variety of academic publications associated to innovation (e.g. Faruq & Webb, 2016; Halkos & Tzeremes, 2013; Safari, 2017), and according to Rosenzweig (2017) long-term orientation is positively and significantly associated with innovation impact. One could expect long-term orientation to have a positive impact on IP, considering that according to Brodbeck, Frese, and Javidan (2002) individuals and organizations in future-oriented societies prioritize long-term outcomes such as economic growth and development and are willing to make the capital investments necessary. Additionally in the present study, various subjects mentioned the

short-term orientation among the institutions negatively affecting IP of the RIS, as for

example:

> You need to have a manager that is looking at short, medium and long term… they
>
> cannot be alone looking at the short term… and many times in the eagerness to go the
>
> result, to arrive at the meeting of this month with good results, they delay the
>
> construction of the future (P15, 15:61).

Innovation knowledge and skills refers to the *innovation-related abilities and*

knowledge possessed by the people in a particular society, that have been acquired through

education, experience, history, and culture (Lee & Law, 2017; OECD, 2011), as well as the

efficient use of techniques for successfully running an innovation process (Livotov, 2015).

Training for innovation relates to the formation of specialized competencies and skills

concerning idea generation, concept development and entrepreneurial initiative, which

provides employees with enhanced awareness and understanding of the innovation process

(Birdi, 2007). For various interviewees innovation knowledge and skills are crucial:

> I think it's that we still, I include myself, we still do not understand well what
>
> innovation means, I think we have an absolutely distorted concept of what it means to
>
> innovate, people believe to innovate, or we as a society believe that innovating means
>
> simply creating something new (P2, 2:28)

According to Scardamalia and Bereiter (2014), innovation tasks require: 1)

knowledge creation, 2) problem solving, 3) invention and discovery abilities, 4) imaginative

expression, and 5) entrepreneurial orientation. On the other hand, Chootongchai and

Songkram (2018) indicated four sequential learning processes in order to develop innovation

skills listed as inspiration, idea selection, invention, and operationalization. As it is plausible,

this informal institution is closely related to the formal education and training system, and

some authors have assessed the importance of innovation literacy and development of the

educational model for improved innovation performance and productivity in industry (Chootongchai & Songkram, 2018; Heinisa, Gollera, & Meboldta, 2016; Luke, 2013; Mota & Scott, 2014).

Next in the list is the civic entrepreneurship, defined as "the free contribution of time and effort to a project for the greater good of society without expectation of financial benefit" (Etzkowitz, 2015, p. 4). At a macro level, this voluntary activity increase economic capital and produce a new civic identity, and at a personal level, it allows self-expression and creativity, generating and opportunity to contribute to the community, so the primary motivation is reputation and the creation of social capital (Etzkowitz, 2015). Interviewees that mentioned civic entrepreneurship are in line with this view:

> There are civil collectives, also from the social point of view, that are very committed to the objectives of sustainable development […], in fact they already make an important social fabric, so I think that there are other institutions... small but that have a very big impact (P10, 10:13).

In relation to the informal institution of global vision, attention have been raised over the relevance to acknowledge the crucial role of global networks and institutions for innovation (Doloreux & Parto, 2005), as the territories are less economically autarchic and the contemporary economic scenario is like a global mosaic of regional economies (Keune & Creation, 2001). As said by Doloreux and Parto (2005) for a better comprehension of RIS´s dynamics, it is crucial to observe failures and successes both locally and globally, considering the importance of this global vision for the competitiveness of firms and regions, in the same line one respondent said:

> Why does innovation make sense? Because companies are competing, it is a global market and if the companies does not advance, if they do not innovate, then other foreign companies will come and eat their market size. I believe that this market at

regional and national level lacks more dynamism. In spite of everything, we are still a

very closed economy (P7, 7:43).

Bonding social capital, also known as social ties (Coleman, 2000), refers to the links,

collective standards, and identifications in culture that nurture social relations of confidence

and collaboration in a society (Lee & Law, 2017). The social ties exert a positive impact over

information flows and innovation, as they promote networking and allow entrepreneurs to

obtain resources and support when pursuing business opportunities and innovation projects

(Crescenzi & Percoco, 2012; Putnam, Leonardi, & Nanetti, 1994; Shane & Cable, 2002;

Titarenko & Kirienko, 2014), and additionally, the bonding social capital help the appearance

of social associations and encourage civic entrepreneurship in the community (Putnam, et al.

1994).

The next informal institution identified as honesty, but also mentioned in the literature

as integrity (North, 2002), has been explored as an important factor for innovation by various

authors (Rauf, 2009). As stated by Crescenzi and Percoco (2012) higher levels of honesty,

ensure compliance of obligations, reduce costs, encourages risk taking and positively affect

innovation by the entrepreneurs, but it is important to acknowledge that objective measures of

honesty are difficult to obtain (Putnam et al., 1994). Trust is closely related to other formal

and informal institutions, as for example honesty, social capital, collaboration, value

networks and formal alliances between actors of the quadruple helix.

According to Lee and Law (2017), trust is at the center of social relations and of

formal and informal structures, because cooperation and knowledge and information flow in

social networks only happens when there is reliance, and it encourages innovation through

the diffusion of information and knowledge (Crescenzi & Percoco, 2012; Lee & Law, 2016).

In relation to trust, one participant said:

So if you do not feel at the same level, you will not be able to communicate, if you

cannot communicate, you cannot generate trust, if you cannot generate trust, you will

not risk in company (P10, 10:31),

The informal institution of creativity and resourcefulness is about optimizing what

you have to work with, in search of creating something new or making things better (Baldoni,

2010). Various authors have considered resourcefulness as an important factor for innovation

(e.g. Baldoni, 2010; Halme, Lindeman, & Linna, 2012; Nickols & Kay, 2015), especially

when having into account the fast changing social and economic global environment (Nickols

& Kay, 2015).

The nest institution, the open innovation proclivity, assesses the inclination of people,

organizations and the innovation systems to utilize external sources and ideas during the

innovation processes (Hung, & Chiang, 2010; Van de Vrande, Vanhaverbeke, & Gassmann,

2010) an academics agree that it is a crucial factor for sustaining innovation and competitive

advantage (Rangus, Drnovšek, Minin, 2016). Rangus et al (2016) conceptualized open

innovation proclivity as the disposition of an organization to carry out open inbound and

outbound innovation, including the following variables to measure it: 1) Inward intellectual

property licensing and external participation, 2) Out sourcing R&D and external networking,

3) Customer involvement, 4) Employee involvement, 5) Venturing, and 6) Outward

Intellectual Property licensing (p.192).

Ambition is another informal institution identified by interviewees, and according to

Levie et al. (2015), high levels of ambitious entrepreneurial activity are related to high rates

of innovative activity. Other authors have also included ambition as a driver of innovation

outputs or as an important factor to consider within innovation systems (Bossink, 2004; Van

Mierlo, Arkesteijn, & Leeuwis, 2010). Hansen and Hamilton (2011) found that ambition was

an important factor when analyzing small firm growers and non-growers, observing that

those firms growers wanted to be renowned for their innovation with ambitions tied strongly to the creation of innovative products or services valued by customers, while the non-growers' ambitions were confined to maintaining their current income. Ambition was also perceived as a positive factor for innovation and the following two quotes illustrate this issue: "Seriously a positive issue is like the locals ambition to conquer things" (P13, 13:9), and "the detonator should be like the will or the ambition of the same company to survive" (P28, 28:85).

The next institution in the list is the resilience, which is the tendency to replicate and reproduce existing activities and ways of working based on adaptation and recovery from crisis and rapid change (Bristow & Healy, 2018). The studies relating resilience and innovation have observed it at a personal (Oeij et al., 2017), social (Keck & Sakdapolrak, 2013), organizational (Lee & Hamamoto, 2017), and regional level (Bristow & Healy, 2018).

At a personal level, resilience is one of the dimensions of a construct called psychological capital, which also includes self-efficacy, hope and optimism and it was found to positively influence IP (Ziyae, Mobaraki, & Saeediyoun, 2015). Team innovation resilience behavior (IRB) is the capacity of the members of a team to "withstand and overcome critical incidents in a manner that enables sustained activity toward the goals of the innovation project by critical recoveries that safeguard team cohesiveness and performance" (Oeij et al., 2017, p. 49). Regional economic resilience is conceptualized as the ability of regions to resist and recover quickly from shocks including all the variables involved in the process and it has been closely related with the innovative capacity of RIS (Bristow & Healy, 2018; Sensier, Bristow & Healy, 2016). Keck and Sakdapolrak (2013) said that social resilience is composed by the ability of social actors to cope with adversities, the ability to learn from past experiences and adjust to future challenges and the ability to create institutions that assure individual and social welfare in face of future crises.

Indulgence, is the informal institutional factor related to the "a society that allows relatively free gratification of basic and natural human desires related to enjoying life and having fun" (Hofstede, 2011, p.2). The degree of indulgence as a measure "evaluates by how much the individuals of a particular culture control their impulses and desires (Prim et al., 2017, p.7). Indulgence is one of the Hofstede's cultural dimensions and it has been previously explored as variable influencing IP in academic research (e.g. Griffith & Rubera, 2014; Prim et al., 2017), but contradicting results have been found. For example, according to the research of Griffith & Rubera (2014) technological innovations decline when indulgence increase, while according to findings of Prim et al. (2017) the greater the indulgence, the greater the innovation output, as according to the authors, this cultural characteristic make people prone to experiment and absorb new experiences creating a greater facility for producing innovation. In the information gathered, the resilience was considered as a positive factor for IP in overall cases, as was expressed by one informant:

> As a culture [what benefited us the most is] resilience. Other countries have had an example of resilience. We pass from a city that was devastated to become the most innovative city in the world (P21, 21:10).

For the next institution, which is democratization of knowledge, according to Scardamalia (2000) it is related to systems that enable knowledge-building processes, rather than presuming advanced knowledge acquisition. Knowledge building systems are those that engage all community members, or allow them, to participate in the knowledge creation dynamic, at the same time sharing useful ideas and progresses and assuring knowledge availability and refinement in a community context. According to the study of Hu, Horng, and Sun (2009), the democratization of knowledge is strongly related to higher IP, reason why organizations should encourage the knowledge sharing behaviors and habits trough

different means, and according to Arocena and Sutz (2014) democratization of knowledge and innovation are crucial for inclusive development.

Perseverance and tolerance for failure, which are the next two institutions on the list, are closely related, and according to Napier-Munn (1997) perseverance, along with vision, faith, long-term support and willingness to take risks, are crucial to achieve IP. According to Comedy and Grama (2016) tolerance for failure, as the ability to deal with failure and overcome frustration, has a critical role in the innovation process, as failure becomes practical knowledge that can be used as an effective tool for innovation when coupled with perseverance. Participants that mentioned tolerance for failure, coincide that for the studied RIS, the low tolerance for failure exerted a negative effect over the IP, and for example one asserted, "In the system the person who fails is punished very strongly, people is not accompanied as part of that learning project, then it is hard to attempt, try, and risk" (P10, 10:80).

Diaz-Moriana et al (2016) identified perseverance as a dimension of long-term orientation and related it with innovation and sustainability of firms, while according to Norling and Statz (1998), in a case analyzed, perseverance by members of a development team was found to be a necessary factor for an innovation to occur.

In relation to teamwork effectiveness, organizations increasingly rely on new product development teams with capabilities to generate creative ideas and carry out innovation projects (Liu, Chen, and Tao, 2015). Blanco et al. (2017) associated the quality of teamwork with the successful development of innovation projects; Poo (2015) stated that innovation in both basic and applied science critically depend on effective teamwork; while Song, Kawakami, and Stringfellow (2010) found that the management promotion of teamwork is a factor positively affecting the IP of the organization, as individualism is a barrier to the effective teamwork required for innovation. Teamwork effectiveness is positively related

with collaborative behavior and social capital, as both informal institutions facilitate the communication, the open-minded discussion and the exchange of creative ideas, which are important conditions for the IP of teams (Liu et al., 2015). It is also essential to contemplate that, as one interviewed pointed:

> The lack of openness in our organizational culture detracts much from the potential for innovation because people start to feel scared, or the teams are filled of people who are not the right ones and good behaviors are not generated for the company to innovate (P15, 15:62).

Optimism is one of the last five institutions identified by interviewees, and as said by Tang, Li, and Yang (2015) a moderate amount of optimism is an integral part of the discovery process, and can be instrumental to firm´s innovation. According to Ali (2014) optimistic people are willing to explore the unknown to achieve goals and are able to build sound institutions, as they want to participate, create, invest, and build new things, inspiring and stimulating others to engage in economic activities related to technological progress. In their research, Hmieleski and Baron (2009) found an inverse relation between entrepreneurs' optimism and the performance of new ventures in highly optimistic entrepreneurs, concluding that it is desirable is to achieve a balance between optimism, realism, goals and forecasting. According to the studies of Hsu, Sheng and Hsueh (2011), and Ziyae, Mobaraki, and Saeediyoun (2015), optimism does not have a direct effect on employees' innovative behavior.

Commitment is an informal institution that has been related to innovation in various studies, in the form of individuals commitment (Iturrioz, Aragón, & Narvaiza, 2015), organizational commitment from employees (Robbins & Judge, 2007), and management commitment to innovation (Hueske, Endrikat, & Guenther, 2015). At a personal level, as said by (Iturrioz, Aragón, & Narvaiza, 2015) when individuals are transformed from being self-

seeking into being members of a community where there are shared interests, reciprocity, and trust, this enforces commitment to innovation and supports the safe environment required to develop innovation projects. Robbins and Judge (2007, p74) define organizational commitment as the degree to which "an employee is in favor of a particular organization and its objectives, and intend to maintain membership in that organization". Aryanto and Fransiska (2012) found that the government support to organization commitment is positively related with government assistance to IP. In relation to employees' commitment, Michie and Sheehan (2003) found that firms that used strategies to create high commitment were more likely to innovate, and according to Sheehan, Garavan, and Carbery (2014) commitment can spur on creativity and subsequent innovation. Academic literature emphasizes that a lack of management commitment or support for innovation may constitute a significant barrier to IP (Hueske, Endrikat, & Guenther, 2015).

Although few respondents identified leadership as a crucial factor for the IP in an RIS, this factor has been previously explored and supported by a great number of academics (e.g. Barsh, Capozzi, & Davidson, 2008; Donate & de Pablo, 2015; Khalili, 2016; Oke, Munshi, & Walumbwa, 2009; Zacher & Rosing, 2015). Lee and Law (2017) stated that, among others, leadership is considered as a main feature motivating somebody to engage in innovative activity, and also when examining innovation culture and its effects on IP, for product innovation, Hu et al. (2009) included leadership as an important dimension for the analysis. Additionally, Lumpkin (2005) found that strategic leaders in companies create a solid motivation to communicate ideas, innovate, assume risks, and seeking new project chances. A respondent from the private sector agreed with this:

> ¿why [they can innovate]? Because they have a structure and a leadership that have allowed organizations to do so, the leader visualize the north, independently of the irrational society, he is able to see the north and look beyond (P25, 25:51).

Another informal institution identified by the participants was the RIS`s learning capacity, clearly differentiating it from the individual or personal learning capacity, which was already included in the informal institutions family, as human capital. This is a very interesting but yet comparatively unexplored concept, as learning, whether by individuals, firms, regions, industries or nations has been largely treated in an undifferentiated manner, even though according to Lawson (2017), learning processes at different levels are not the same. Learning is at the core of the definition of an RIS (Cooke et al., 1998), but it has been usually examined from the point of view of individuals (e.g. Von Tunzelmann, 2009) or organizations participating (e.g. Edquist, 2013), rather than the learning dynamics of the regional system itself, as a collective process.

Institutional factors as collective learning and learning regions, closely related to RIS´s learning capacity, but not the same, have been addressed in different studies, in which their role in the generation of IP has been recognized (e.g. Azman, Sirat, & Ahmad, 2014; Capello & Faggian, 2005; Mattes, Huber, & Koehrsen, 2015; Perry, 2014; Kirat & Lung, 1999). Knowledge prosper in individuals and within organizations because of cumulative production of knowledge (Capello & Faggian, 2005) and learning processes, which are path-dependent, reason why it is imperative to reflect the protagonist of the institutional framework in knowledge creation and flow (Kirat & Lung, 1999). This informal institution as an important variable for IP of RIS, needs further research and clarification, as it is very diffuse, and by definition is still hard to conceptualize.

Even though the informal institution of religiosity, according to the quantity on mentions by the interviewees, is almost at the button of the list, this variable has been previously observed and assessed in relation to IP in several studies. According to McDaniel and Burnett, J. (1990) religiosity is more psychological and behavioral phenomenon, which reflects the degree of commitments in a specific religious values, beliefs, and ideals, which

are adopted and practiced by an individual. As said by Adhikari, & Agrawal (2016, p. 230), "the dominant religion in an area affects local culture and systematically influences the behavior of local residents even if they do not personally adhere to that belief system", and regional or local religious composition may be associated to innovation. People usually transfer religious values to their tasks of everyday life, includes business practices, entrepreneurial behavior and decision-making (Gursoy, Altinay, & Kenebayeva, 2017). In addition, Bénabou, Ticchi, & Vindigni, (2013) found a robust negative relation between religiosity and number of patents per capita and that greater religiosity is significantly associated to less favorable views of innovation, and Mansori, Sambasivan, and Md-Sidin (2015) found that religiosity influences openness to change and innovativeness of individuals. Additionally according to El-Haq, Abdelaziz, & Mohamed, (2016) the religion factor was negatively related to creativity.

In the last place of the list, two subjects identified the foreign language proficiency as an informal factor affecting the IP, by saying: "the other thing that does not help is the lack of English of the people in this city" (P26, 26:16), and "the issue of the language [is important]. To learn a second language then, or a third or fourth or fifth" (P18, 18:37). For the context studied, foreign language proficiency is seen as the competence or ability to use a foreign language for professional purposes (Shmatko, 2016), and to facilitate multicultural collaboration in a culturally diverse and globally networked business environment (Jensen, 2017). The second or foreign language proficiency forms part of a construct named communicative competence (Savignon, 2018). According to Omelyanenko (2017), OECD specialists' consider the language factor as one of the main variables influencing the degree of national science internationalization. In academic databases, no empirical articles directly relating the language factor with the IP were found, but due to the influence of this variable on personal learning process, professional performance and global networking, a positive

relationship is expected. Table 15 presents the 31 informal institutions classified in more

general categories, as (a) behavioral factors, (b) attitudinal factors, (c) capabilities, or (d)

competences, including the theoretical definition of each category.

Table 15

Types of Informal institutions influencing the IP of an RIS

Category	Explanation	Institutions within the category
Attitudinal factors	Attitudinal factors are psychological constructs that transform into mental and emotional traits that characterizes a person, influencing the individual's thought and action (Perloff, 2017)	Innovation supportive culture Regional identity Market orientation Egocentrism Time orientation Global vision Trust Creativity and resourcefulness Ambition Resilience Indulgence Optimism Religiosity
Behavioral factors	Behavioral factors comprises the human behavior in organizational settings (Moorhead & Griffin, 1995); and their study includes the individuals behavior in organizations, the behavior at work groups and how organizations behave at a macro-level (Wagner & Hollenbeck, 2010).	Risk taking Social innovation orientation Interaction and collaboration Bonding social capital Honesty Open innovation proclivity Perseverance Tolerance for failure Commitment Civic entrepreneurship
Capabilities	Capabilities include the integration of behavioral, economic and social factors, adapting them to specific contexts facilitating learning. Therefore, they are the result of adaptive learning processes, which includes different internal features and contextual factors (Von Tunzelmann & Wang, 2003).	Human capital Entrepreneurial orientation Innovation knowledge and skills Democratization of knowledge
Competences	A competence is a consequence of the successful use of a set of capabilities that enhance performance, and then a person with capabilities can only develop competences by learning and practicing (Von Tunzelmann, 2009).	Teamwork effectiveness Leadership RIS learning capacity Foreign language proficiency

As so many informal institutions were found to be relevant, epistemologically there was a need to simplify categories for further analysis, and to reduce these categories to a more simple structure, and according to Spiggle (1994) abstraction builds on categorization. Abstraction goes beyond the identification of patterns in the data, incorporating concrete categories into fewer more general ones, and surpasses categorization by placing categories into higher-order conceptual constructs (Spiggle, 1994). According to the data, the majority of informal institutions affecting organizational IP, identified is the RIS correspond to attitudinal or behavioral factors, while few correspond to capabilities and competences, but all of them are important for the IP of the organizations within an RIS.

Institutions positively and negatively influencing the IP of an RIS.

After the analysis of the data for themes E and F, which are the "Institutions positively influencing the IP of an RIS" and the "Institutions negatively influencing the IP of an RIS", 47 emic codes were identified for the first theme and 43 for the second (see Table 16 and 17). Most of those codes only had a single mention across all interviewees, therefore, in order to elaborate propositions, which could derive in hypothesis for future research, only the codes with ten mentions or more were considered. It is important to note that in the previous themes related to formal and informal institutions, participants mentioned all institutions they knew or recognized without making any distinctions of their positive or negative effect over IP, while themes E and F are based on the identification of the institutions negatively and positively influencing the IP of organizations within the RIS. It is important to mention that in accordance with Tridico (2013), efficiency of institutions on the present study does not mean that they have to minimize transaction costs, as traditionally stated by North (1991); institutional effects are positive when they accomplish their original aims and support the IP of the RIS. See the complete lists of codes for themes E and F in Appendix I.

Innovation intermediaries gained special attention as they appeared in both positive and negative factors influencing IP, as it is possible to observe in Tables 16 and 17. Howells (2006) defined innovation intermediaries as:

> An organization or body that acts an agent or broker in any aspect of the innovation process between two or more parties. Such intermediary activities include helping to provide information about potential collaborators; brokering a transaction between two or more parties; acting as a mediator, or go-between, bodies or organizations that are already collaborating; and helping find advice, funding and support (p. 720).

Table 16

Institutional factors positively influencing the IP of organizations of an RIS

Institutional factors	Verbatims from interviews	Propositions
Innovation supportive culture (informal institution)	"I think it is the first step and probably the most important, that there is the desire and the will to see how we contribute to innovation" P3. "All that has been achieved is a positioning to innovation as a transformer axis of society" P9. "People have to believe more, because when we pass that tipping point, it becomes unstoppable" P21.	Innovation supportive culture is a prerequisite for IP, as it has the transformational power to shift mentality and move the society. Higher IP rates are expected to be observed in those RIS operating within societies presenting higher levels of innovation supportive culture
Education and training systems (formal institution)	"They have done an excellent job in the last five, six years... strengthening the capabilities" P12. "This is a very important part: training your staff for the future" P14. "Work a lot on the training of people […] or the talent, because when there is the sector but there is no talent, there is not much to do" P20.	Education and training systems, in line with innovation and highly contextualized to the needs of economic sectors are crucial for IP. The better the quality of education and training systems for people and organizations, the higher the levels of IP expected within the RIS.
Well-functioning of public innovation intermediaries (formal institution)	"What I think is that all these [intermediaries] were born in order to strengthen the support based on science, technology, and innovation […] and have done an excellent job" P12. "They directly declare the importance given to innovation […] and it`s a statement that moves all the actors of the system" P22. "They carried out this work of developing the system to generate different programs […] from training to capital issues, and all these programs help organizations" P22.	Innovation intermediaries, especially those created by the government, are clearly important to support the RIS, as they not only provide resources and training, but also create awareness and set realistic shared goals. The well-functioning of these public innovation intermediaries, exerts a positive impact over the IP of the organizations within the RIS.

Table 16

Institutional factors positively influencing the IP of organizations of an RIS (continuation)

Institutional factors	Verbatims from interviews	Propositions
Entrepreneurial orientation (informal institution)	"The character of an entrepreneurial culture is to seek solutions and to find answers, find ways to do... and we do, we try even if we are wrong" P17. " The culture of Medellin […] greatly favors entrepreneurship, it is a culture where it is very valued when a person is taking risks creating something with his idea, his own business" P20." Innovation is 1% idea, 99% perspiration […]; our talent can draw innovations ahead because it is an entrepreneurial culture" P21.	Entrepreneurial orientation is associated with other informal institutions, such as resourcefulness, risk taking, innovation supportive culture, and resilience, among others, and highly related with IP. People with entrepreneurial orientations are able to generate ideas, create goals, and work hard to achieve those goals. Higher levels of entrepreneurial orientation should be associated with higher levels of IP.
Mechanisms of knowledge transfer (formal institution)	"Another issue that I find impressively positive is the platform SUNN 4i, it's like you have a knowledge transfer office, transfer between start-ups […], it is like the creation of ecosystems that allow innovation spontaneously and permanently" P13. "Requires those who are generating the knowledge to be very connected to the needs of the market" P24. "I basically see a very big effort to educate doctors [PhDs] but not to produce science that generates applicable knowledge that solves problems and generates wealth" P26.	Mechanisms of knowledge transfer are seen as an important factor for the IP to occur. These mechanisms are not only valued by their number or coverage; but especially for their relevance, and for being appropriate to solve actual problems in context. Therefore, this proposition is composed by two assumptions: the greater the number of knowledge transfer mechanisms and the higher the level of relevance of the knowledge transferred, the higher the level of IP.

According to Klerkx and Leeuwis (2008), innovation intermediaries include consultants, brokerage organizations that create networks, organizations in charge of formal mechanisms for the sustenance of IP at a systemic level, databanks that display relevant knowledge and entities that help in the consecution of resources, financing or subsidizing for innovation. Additionally, the well-functioning of innovation intermediaries depends on several factors such as: "1) visibility and accessibility, 2) credibility, 3) access to appropriate sources of knowledge and information relevant to the innovation process, 4) quick response to the requests, and (6) complementarity to the weaknesses of the organizations it serves" (Klerkx & Leeuwis, 2008, p. 264). The institutional factors negatively influencing the IP of

organizations within an RIS, the verbatims from interviews and the propositions generated

are exhibited in Table 17.

Table 17

Institutional factors negatively influencing the IP of organizations of an RIS

Institutional factors	Verbatims from interviews	Propositions
Lack of market orientation (informal institution)	"In the processes of innovation [...] people believe that the ideas and to make a bank of projects is the most important and it turns out that the most important is to execute that projects" P15. "The innovation that these entrepreneurs bring, to apply to reality or their business, is not feasible, not easily sociable and replicable" P12. "There are still research groups from technological development centers and universities that are perhaps developing a lot of things that may not have a market" P24.	Market orientation, was described as important not only for private firms and industry but also for entrepreneurs, and for academic research centers, and researchers. When actors of the RIS place more importance on ideas and projects, than on pertinence, viability and execution, this affects IP. The stronger is the lack of market orientation the lower are the IP levels expected within the RIS.
Unclear roles of public innovation intermediaries (formal institution)	"What I would say is that they [the intermediaries] are fighting for the cake are fighting for the same cake instead of trying to increase the size of the cake" P7. "What I think that slows innovation in the region is that there are many institutions that have championed the same issues and are fighting among them to offer same" P15. "I feel that we do not lack institutionality but instead we are over-institutionalized" P17.	In the factors positively influencing IP the well-functioning of public innovation intermediaries was mentioned, but at the same time, when public innovation intermediaries present unclear roles and functions, lower levels of IP in the RIS are expected. Consequently, the relationship between the number of public innovation intermediaries and IP will be possibly expressed by an inverted-U function.
Statutes and organizational rules constraining innovation (formal institution)	"In an industrial world there are hierarchies, many people do not realize the change and want to continue to apply hierarchies in formal institutions and that is not right" P10. "Many employers are still governed by stupid rules and employee-monitoring work schedules, employee assessment, which makes no sense to this day" P2. "If the mandate does not come from management, it becomes more difficult; because finally I am in my day to day and not in innovation" P14.	Not only the government is in charge of place innovation at the core of strategic plans and policies, but also it is also required that organizations internally alienate with the purpose, and internally institutionalize innovation processes and practices. The more constraining are the statutes and the organizational rules of RIS actors, the lesser the levels of IP.

Table 17

Institutional factors negatively influencing the IP of organizations of an RIS (continuation)

Institutional factors	Verbatims from interviews	Propositions
Bureaucracy and legal complexity (formal institution)	"There is a level of regulation so high in all that it is impossible to be in full compliance" P3. "It puts obstacles that take away the motivation to invest in innovative ventures" P12." It takes too much the protection of intellectual property, we have a patent that took us 6 years to be approved, in 6 years is already obsolete" P15.	Legal complexity not only obstructs the innovation to occur, but from the beginning prevents individuals and organizations to even try, in the face of the legal problems they foresee. The bureaucracy and legal complexity within an RIS is negatively related with the IP levels
Uncertainty avoidance (informal institution)	"We have a family […] with very conservative ideas of how to cope with life, afraid to take on challenges, I think that is the main disadvantage, that fear of taking risks, that fear of assuming different things" P6. "Here we are shortsighted and low risk. So that means that it is very complicated to have high achievements in innovation, because innovation requires a bet so that something disruptive can come out" P17."We are conservative […] innovation requires being calm in front of risk" P24.	Innovation is a process of uncertainty that in most cases and requires challenging the status quo and taking risks. This are the reasons why behavioral factors related to uncertainty avoidance, exert a negative effect over IP levels; the higher the uncertainty avoidance of the society the lower the level of IP within the RIS.

It is relevant to analyse how in both cases, for the factors positively and negatively influencing IP, an informal institution came first, according to the patterns found on data collected from respondents. Additionally, this two informal variables identified in first place (innovation supportive culture and lack of market orientation), are classified as attitudinal factors, as was presented in Table 15. The ten propositions presented in Table 16 and Table 17, are expressed as hypothesis for future research in chapter 5.

Even though informal institutions seem to be crucial for IP, it is important to acknowledge the relevance of formal institutions, as according to interviewees governmental, organizational and educational factors also affect the innovation levels within an RIS. These findings are in consonance with the results and analysis of the last theme presented in the

next section, in which the impact of informal versus formal institutions over IP is discussed. Finally, the well-functioning of public innovation intermediaries was listed as one of the institutional factors positively influencing IP, but when there are many in the RIS, and they overlap functions or compete for the same resources, the effect on IP tends to be negative, as the following quote from an interview suggests:

> The first thing that I think is undermining innovation in the region is that there are many institutions that have championed the same issues and now are fighting among themselves for the same offers (P15, 15:37).

Institutions with a greater effect over the IP of an RIS.

For the last theme, which is the "Institutions with greater effect on the RIS´s IP", the participants defined, according to their knowledge, which kind of institutions (formal or informal) exert a greater effect on the IP of the actors participating in the RIS. After the analysis, the informal institutions were identified by the majority as those having a greater impact over IP of the RIS. The reasons indicated and the verbatims supporting these findings are shown in Table 18.

After data processing and analysis it was found that 14 interviewees expressed that informal institutions are those that exert a greater impact over IP within the RIS, 4 interviewees identified the formal institutions as those having a greater impact, and 5 five interviewees said that both, formal and informal, are equally impacting the IP of the actors in the system. As observed, the majority of respondents pointed towards the greater relevance of informal institutions, and the reasons to support this claim were that those institutions create dynamics of innovation even without the support of formal institutions, and finally allow people to accept and embrace formal institutions. In addition, participants said that informal institutions are the ones that influence the most the human behavior and actors' performance, they are deeply rooted and they are much more difficult to transform than formal ones.

Table 18

Institutions with greater effect on the RIS´s IP

Type of institution	Reasons	Verbatims from interviews
Informal Institutions	1. They allow people to embrace formal institutions 2. They can create dynamics of innovation even without the support of formal institutions 3. They influence the most the human behaviour and performance 4. Because formal institutions just respond to a social dynamic that need to be regulated 5. They are deeply rooted and are more difficult to transform than formal ones	"The informal because they are those that generate the open [innovation] dynamics throughout the social conglomerate" P9. "It is totally clear that the ones that affect the most are the informal ones, because by the same definition of an ecosystem, ecosystems work by the dynamics of the components, in a natural ecosystem there are no formal institutions" P10. "I think the informal ones, because these are the habits, the culture, from what the formal ones are generated. In fact, if you start to observe where the laws are generated, usually what happens is that a society starts to have certain behaviors until there comes a time when this has to be regularized, and then the laws respond to that social dynamic" P24.
Formal Institutions	1. They provide grants 2. They help create or reaffirm informal institutions 3. They generate the systemic process 4. They provide or facilitate resources	"The government has to be willing to take risks or give at least that first step, right? Sensitize… and to the extent that the government grants these tools, grants infrastructure and those spaces, we as human being to see what we have are able to contribute also to the system" P2. "Obviously, for the ecosystems by design, the most important institutions are the formal ones. Because it begins by creating formal institutions that regulate the performance of the ecosystem, good formal institutions are giving line to create or reaffirm some informal institutions "P13.
Both equally	1. They interact with each other dichotomously in a continuous process were both are equally important 2. They depend on each other and affect each other	"The same, because I believe that one without the other cannot exist" P16. "The non-formal is the culture that feeds the formal and formal increases the non-formal, and then they cannot be separated because there would be an imbalance" P21. "I say both, the formal ones because they use all the resources to do it, but also the informal ones, since there are other tools and other platforms where those informal ones are disseminated and endorsed, and that impacts in a positive way" P25.

These results are in line with Tridico (2013), as he claimed, "given the concept of institutions, which includes both formal and informal institutions, it is no longer sufficient to change formal institutions in order to achieve another system. What is more important is to change the mentality of economic agents" (p. 9). In his firsts texts North gave predominance

to the formal institutions as the axis of the social structures (North, 1991), subordinating informal institutions to a supporting role or an element that needed to be considered ancillary. In later works, North recognized the importance of the informal institutions in shaping transactions and decision making process of all agents involved in a social system (North, 2002) and he said that "it is norms of behavior, however, that probably provide the most important sources of stability in human interaction" (p, 53).

On the other hand, those interviewees affirming that formal institutions have a larger influence over IP, expressed that formal institutions generate the systemic process, provide grants and resources and help create or reaffirm informal institutions. Both perspectives are valuable, and it is undoubted that both types of institutions influence IP levels, but according to data patterns, the logical proposition is to expect a higher effect of changes in informal institutions over IP, than the effect from changes on formal institutions. Questions about operationalization of variables and future measurement will be discussed on chapter 5.

Stage 4: Segmented Content Analysis

In this last stage, post-hoc segmented analysis were performed and the tendencies on the perceptions of each one of the actors of the quadruple helix were identified. A post-hoc analysis implicates observing the data and the information after the study has been finished, in order to find relevant patterns that were not primary objectives (Hollenbeck & Wright, 2017), and these segmented analyses performed are considered as post-hoc, as they were not part of the main questions of the study and were not foreseen in the research proposal. To define those trends, radar diagrams were used; and on the diagrams, each of the edges is composed by the factors to be analyzed using the information collected from the informants, while the results are superimposed and classified. Radar diagrams, helped to visualize tendencies among the responses of the participants of the study, and for this stage on analysis, organizations included in the sample were classified according to their role in the quadruple

helix as government, industry, university or civil society. The segmented analysis by organization type allows, not only to understand the most common perceptions of all interviewees in relation to each theme, but also, if there are similarities or differences on perceptions of participants according to the type of organization they are representing. The radar diagrams and the segmented analyses are presented for each theme of the research.

Definition of an RIS by type of actor.

As can be observed in Figure 3, the articulation of different elements to increase innovation was the most common definition and even the most mentioned by all kinds of actors, and for the case of civil society accompanied by the definition of the RIS as a social system to support society welfare. All other actors, in higher or lesser degree, also defined the system with a focus on social welfare, which becomes an important component to the system´s definition from the perspective of interviewees.
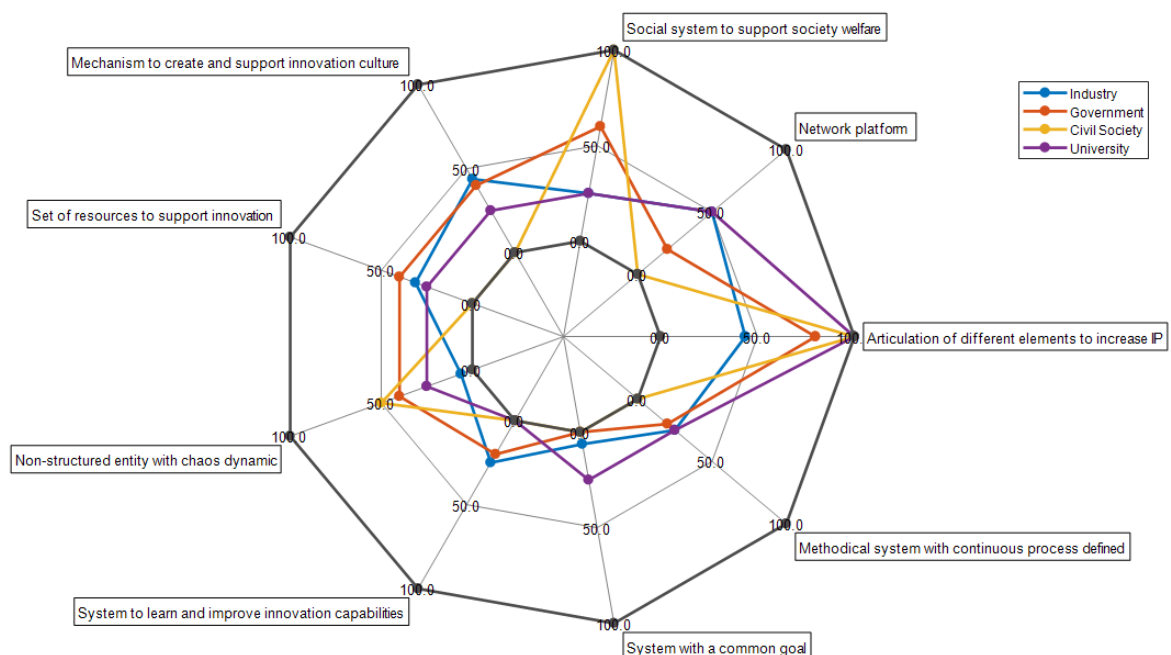

Figure 3. Radar diagram for the codes included in the "definition of an RIS".

For the case of both, the university and the industry representatives, the second most important definition included the networking perspective, which was not mentioned by any actor of civil society. It is important to mention the relevance of the definition of an RIS as a

non-structured entity with chaos dynamic, as all types of actors in different proportion cited this definition. The definition less popular was the one identifying the RIS as a "system with a common goal", what does not mean it is less important.

Reasons to engage and participate in an RIS by type of actor.

There are three reasons to participate in s RIS that were mentioned by all type of actors, in higher or lesser degree, which are "for connections and networking", "for an organizational declaration towards innovation", and "to contribute to the system". The most accepted reason to engage in an RIS is for connections and networking, being especially shared by those members of the academic type, and in line with the previous definition of the system as a network platform, and also with various formal and informal institutions pointing towards networking, interaction, collaboration and teamwork. Results of the segmented analysis for this theme can be consulted in Figure 4.
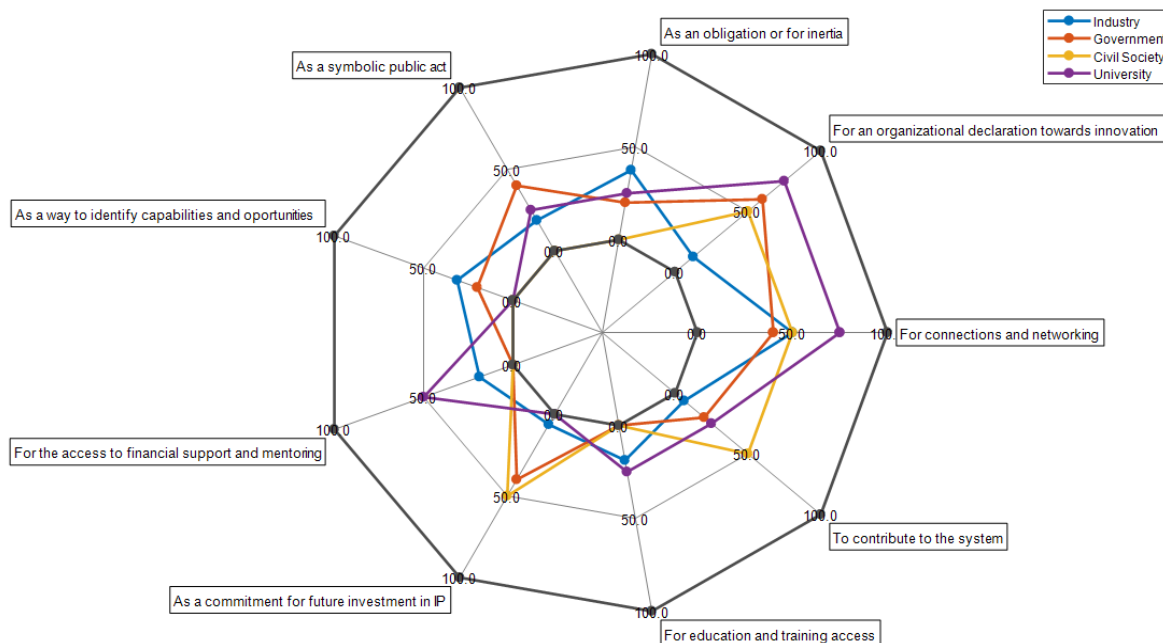

Figure 4. Radar diagram for the codes included in the "reasons to engage in an RIS".

Interviewees from the university and from civic associations also remarked the adherence to the RIS as an organizational declaration towards innovation, what means organizations recognize the importance of innovation, replicate it, and are committed to it. Informants from academic organizations also highly agreed that one of the important reasons to engage and participate in an RIS is for access to education and training. Participants form civic associations and from governmental organizations recognized the importance of translating commitment to actual investment. In particular, commitment to the system and investment in innovation are largely drivers of innovation systems (OECD, 2007).

The reasons listed as "a way to identify capabilities and opportunities", "for the access to financial support and mentoring" and "for education and training access" are less popular among actors. It is also important to mention that for some representatives of the university, industry and government, one of the main reasons to engage is for obligation or inertia. This has implications that will be discussed in chapter 5.

Formal institutions influencing the IP of an RIS by type of actor.

It is interesting to observe that most formal institutions identified, were mentioned by respondents from all types, which can be interpreted as an appropriate knowledge from respondents about the RIS institutional framework, but it is also important to notice that interviewees from civil society did not mentioned some of the formal institutions that all other actors did (see Figure 5). The most visible formal institutions of an RIS according to respondents by type of actor, are the "investment, incubation and acceleration programs", the "mechanisms of knowledge transfer", the "government RD&I initiatives", and the "value networks". Only those informants from the government and the industry, mentioned the importance of government-industry alliance, and this might be due to the lack of knowledge from the other parties about those alliances.
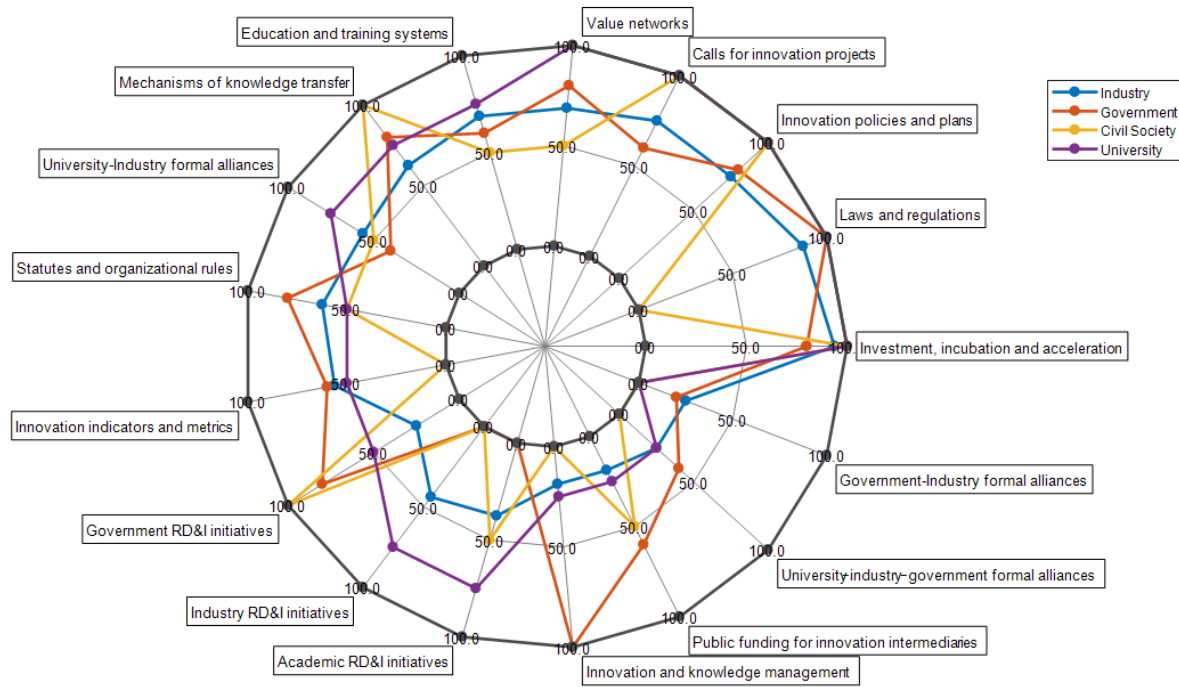
Figure 5. Radar diagram for the "Formal institutions of an RIS".

It is also interesting to see that representatives from government identify the importance of RD&I initiatives but only when they are in form of alliances, as they did not mention RD&I initiatives carried solely by industry or solely by the university, as important institutions for the IP. This is coherent with the definition of RIS predominant for this type of actors, as they mostly declared that an RIS is an articulation of the different elements in which the organizations engage mainly for connections and networking. Finally, the other main formal institutions expressed by the subjects representing the civil society helix, are the "innovation policies and plans", the "calls for innovation projects", the "mechanism for knowledge transfer", and the "government RD&I initiatives".

Informal institutions influencing the IP of an RIS by type of actor.

Informal institutions are numerous, intangible, and harder to identify and classify than the formal ones, which is reflected in the dispersion of appearances among the different types of actors of the RIS. As can be notice in Figure 6, the "innovation supportive culture" is without any doubt the most mentioned institution when performing the individual as well as the collective and segmented analysis by type of actor of the quadruple helix.
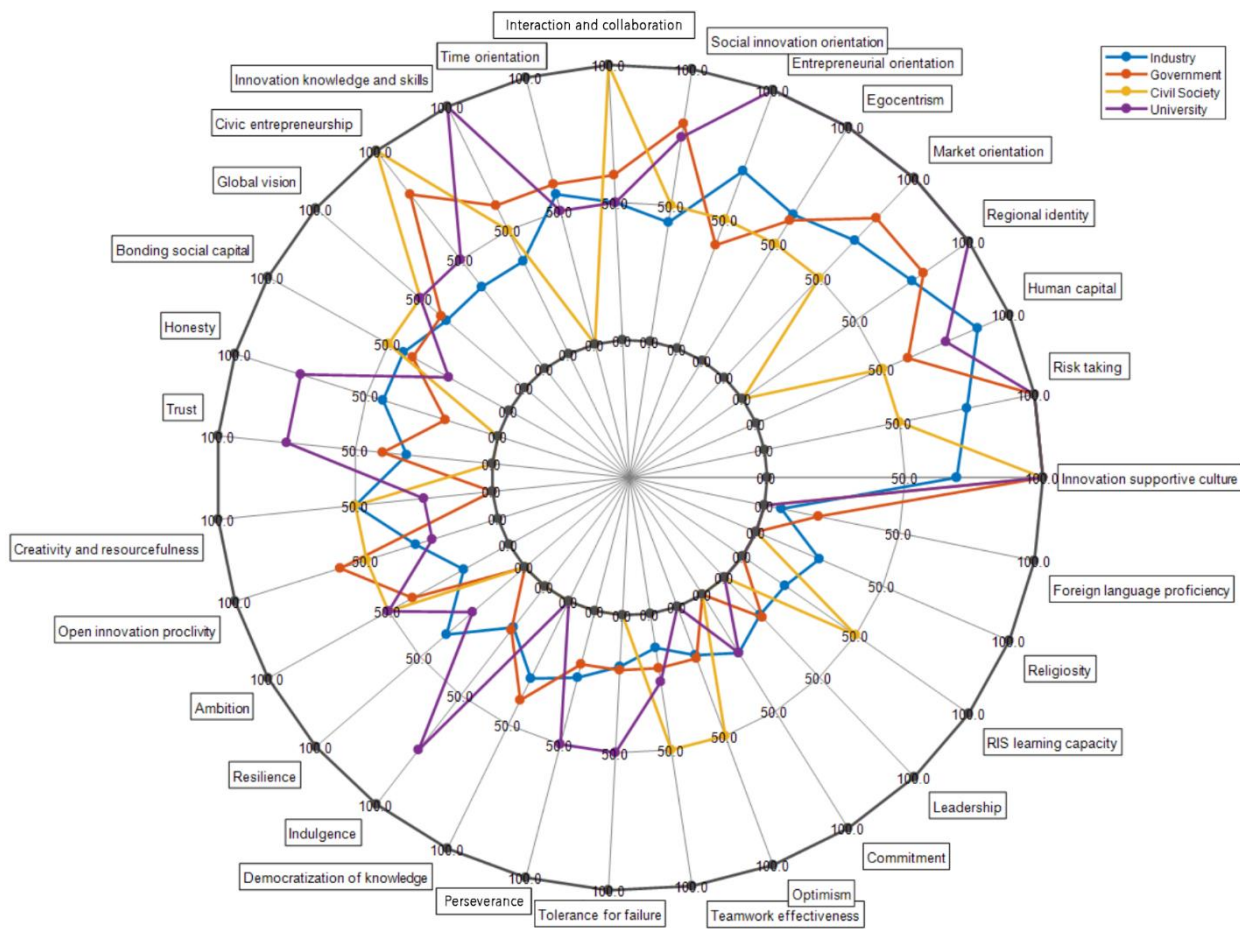

Figure 6. Radar diagram for the "Informal institutions of an RIS".

According to the data collected from the academy, the informal institutions of "innovation knowledge skills", "entrepreneurial orientation", "regional identity", and "risk taking" are equally important. On the other hand, participants from civil society additionally remarked the "civic entrepreneurship", and "interaction and collaboration"; governmental

representatives highlighted the role of "social innovation orientation", "civic entrepreneurship" and "risk taking"; while the most mentioned informal factor across interviewees from industry is the "human capital". In addition, participants from the university side constantly mentioned three attitudinal informal institutions that affect the IP of the RIS, which are honesty, trust and indulgence. It is valuable to notice that the majority of the most relevant informal institutions analyzed by actor type belongs to the category of *attitudinal factors*, except for social innovation orientation, honesty, and civic entrepreneurship, which are *behavioral factors*, and human capital and innovation knowledge, which are *capabilities*.

      To summarize the most important findings of the study, the synthesis of the analysis is presented in Figure 7, which shows the complete institutional framework of an RIS, including the formal and informal institutions affecting the IP of the organizations, as well as the post hoc segmented analysis according to the type of actor within the quadruple helix. This figure was structured considering the information retrieved and processed in the study, and according to the TA structure. The RIS is linked to the IP trough the existence of organizations and institutions interacting within the system (see Figure 7), as was already acknowledged by multiple authors (e.g. Edquist, 2001; Hage & Meeus, 2006; Varsakelis, 2006), but additionally, the main contribution of the study to the innovation economics theory, and the innovation systemic approach, is that the institutional framework is clearly specified and classified by formal and informal institutions as defined by North (1991; 1992; 2005). Additionally, the most important factors of the institutional framework according to the organization type are presented, classifying the actors, conforming to the quadruple helix model as university, industry, government or civil society (Etzkowitz & Leydesdorff, 2000), and also as formal or informal organizations (North, 1992; 1992).
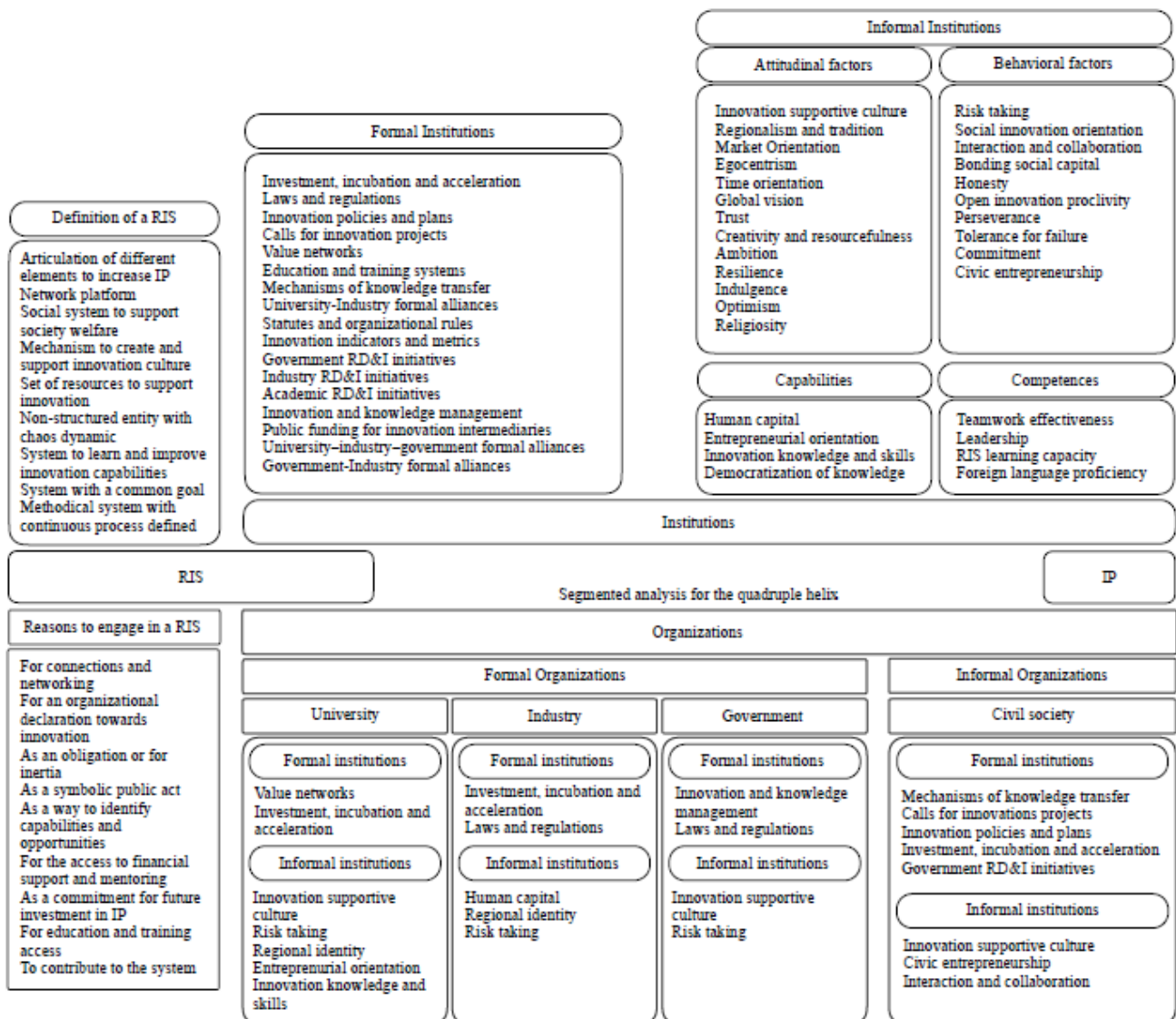
Figure 7. RIS´s institutional framework and key institutions for organization type.

Factors positively influencing the IP of the RIS by type of actor.

The five factors identified as those with higher positive influence over the IP of the RIS were the innovation supportive culture, the education and training systems, the well-functioning of public innovation intermediaries, the entrepreneurial orientation and the mechanisms of knowledge transfer. When performing the analysis by actor type, presented in Figure 8, it was possible to see different patterns among different actors.
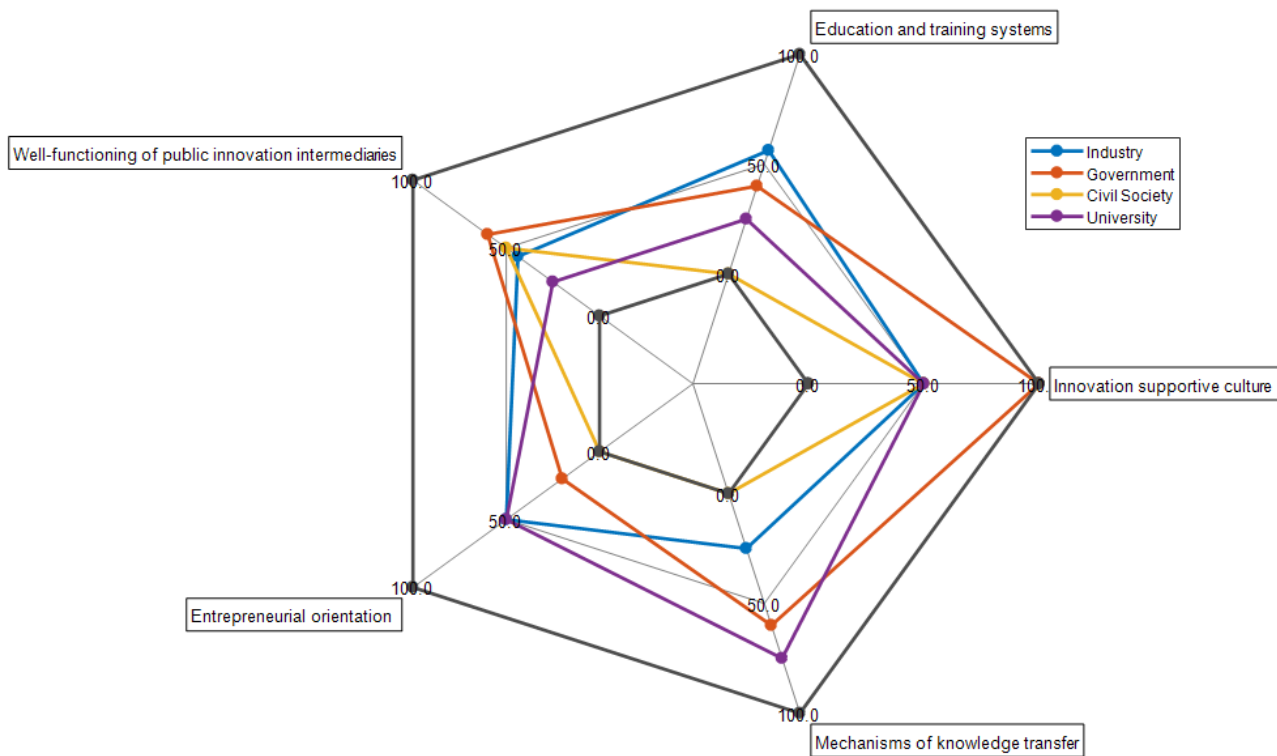
Figure 8. Radar diagram for the "institutions positively influencing the RIS".

Participants from the university emphasized on the positive influence of the mechanisms of knowledge transfer, while representatives of the industry highlighted the importance of the education and training systems. Governmental informants were fully inclined towards the positive role of innovation supportive culture, and respondents from civic associations remarked the well-functioning of public innovation intermediaries and the innovation supporting culture, as the factors with a greater positive influence over IP.

Factors negatively influencing the IP of the RIS by type of actor.

The unclear roles of innovation intermediaries, is the institutional factor with a greater negative effect over IP, as expressed by the informants representing the different types of actors of the system (see Figure 9). Both industry and government parties recognize the negative effect of "statutes and organizational rules constraining innovation" and

"bureaucracy and legal complexity", and this two constructs stand for regulatory deficiencies, but one is related to an internal factor of firms while the other is linked to the public administration, to policies and laws, which correspond to the government side.
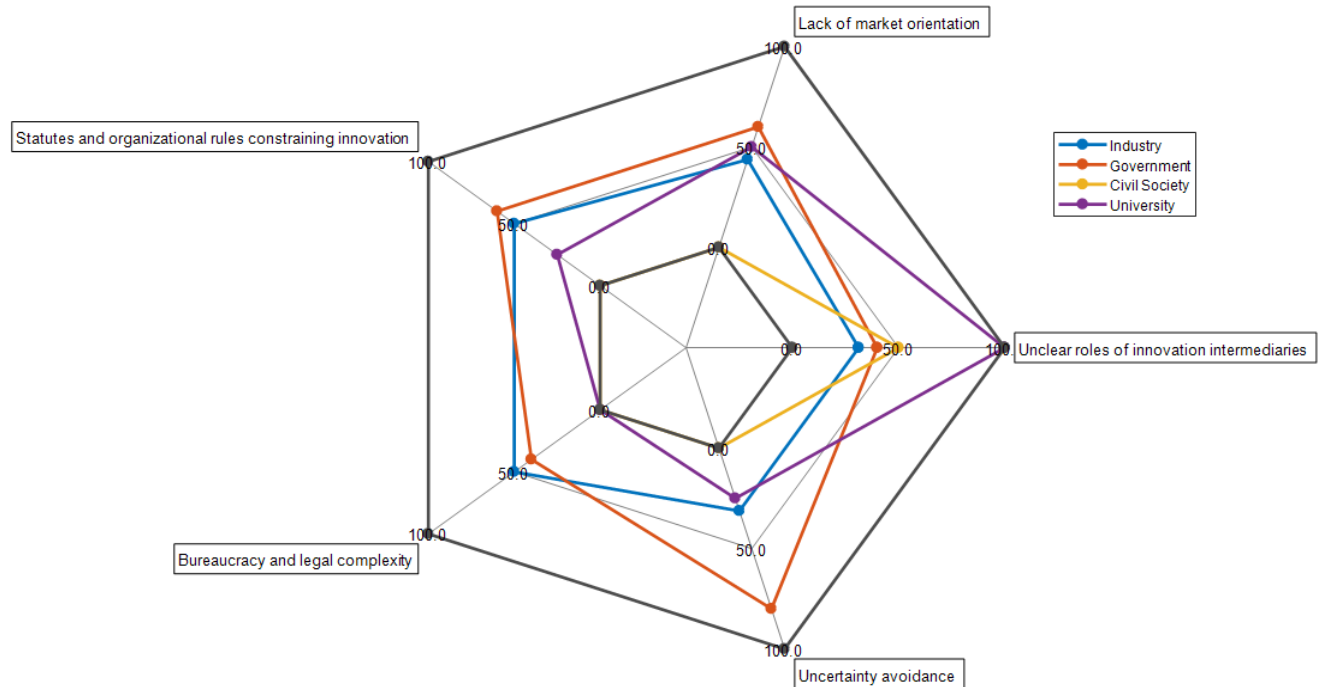

Figure 9. Radar diagram for the "institutions negatively influencing the RIS".

Observe that respondents from industry are stronger when pointing the negative effect of "bureaucracy and legal complexity", while governmental informants placed the focus on the inadequacy of "statutes and organizational rules". The "lack of market orientation" seems to be similarly perceived as negative for IP by the university, industry and government and not by the civil society representatives. Uncertainty avoidance, that can be also interpreted as lack of risk taking (it is a continuum from the same scale), was strongly mentioned by interviewees from governmental organizations, in lesser degree by industry and university, and non-identified by members of civic associations.

Type of institutions with greater influence over IP by type of actor.

When asking informants about the type of institutions influencing the most, the vast majority indicated that informal institutions are the ones affecting the IP in a greater degree,

but it is important to notice that full consensus in any of the answers, was not achieve for any of the four types of actors of the quadruple helix, as is possible to observe in Figure 10. Full consensus would look like a line ending at the top end of the axis, indicating that 100% of the respondents from one category gave the same answer to that particular question, which is not the case for this analysis.
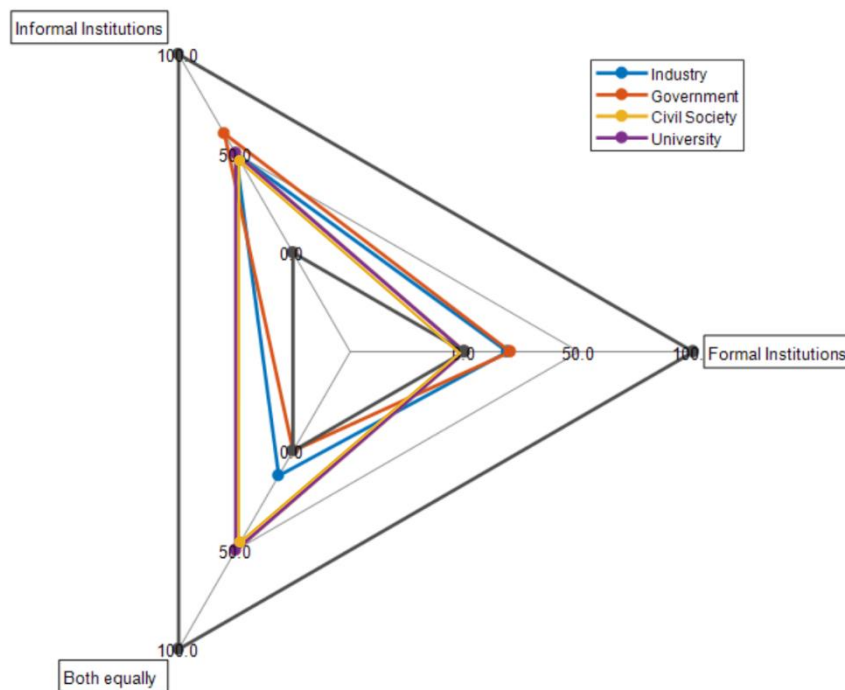

Figure 10. Radar diagram for the "Type of institutions with greater influence over IP".

Representatives of the university answered the "informal institutions" and "both equally" in the same proportion, while partners from industry mentioned the "informal institutions" in a greater degree but also mentioned "the formal institutions" and "both equally". The majority of representatives of government selected the informal institutions but some also selected the "formal institutions", while for the case of informants from civic associations it was similarly distributed between "informal institutions" and "both equally".

Chapter 5: Conclusions and Recommendations

The central claim of this thesis, when using North`s view of new institutional economics as the theoretical framework, is that we can understand RISs functioning, evolution and change by understanding the role of the institutional framework for innovation and how these institutions emerge, advance and adjust in time. As claimed by North (2002), "we can only understand historical change by modeling the way institutions evolved through time" (p. 54).

The results of the study suggest that the institutional framework, including formal and informal institutions, exerts a major role for organizational IP within the RIS, as it generates and promotes appropriate procedures and practices to enhance regional innovation potential, reason why the institutional framework and its particular institutions should be adequately identified, categorized and explained. According to the data collected in the present study by the application of semi-structured interviews, all participants perceived the institutions of the RIS as key elements to IP, as they affect organizational capabilities to innovate, enable innovation process, and are crucial to achieve the social arrangements required for innovation to occur. Furthermore, information about the positive and negative effects from these formal and informal institutions was gathered.

This detailed instrumental case study helped illustrate the interesting and distinctive characteristics of the institutional framework of an RIS, but it is important to recognize that the context specificity of the case means that it is not appropriate to generalize the results or affirm that particular findings will apply to all other RISs.

It is possible to observe through the data that one of the main components of the RIS is related to the ability to connect and create formal or informal alliances, in order to joint capabilities, resources and knowledge to increase innovation levels. Collaboration and interaction are the rationale behind the existence of an innovation system, reason why when

analyzing the institutions of an RIS it is logical to find that many of them are connected to this particular aspects (i.e. value networks, knowledge transfer, formal alliances, regional identity, and teamwork effectiveness), hence, it is important to differentiate institutional variants in relation to interaction and collaboration. In the first place, the collaborative attitude is an informal institution that arises from the personal disposition of those who are part of a society, to interact in an open manner, and to embrace collaborative projects internally or externally. In parallel, there are formal institutions created to help develop this collaborative attitude, as is the case of value networks, where the interaction is organized and certain parameters are created to regulate participants' behavior. Meanwhile, in some scenarios there is a materialization of the desire to interact and collaborate, which translates into formal alliances between two or more actors of the quadruple helix, and these alliances were listed within the formal institutions because they are governed by contracts or written agreements, which specify rules for behavior, commitments and consequences arising from the infringement of these. It should be noted that, as expressed by interviewees, the government strategic plans, policies, and, state laws, as well as the education and training systems could also motivate or discourage the willingness to collaborate among the multiple actors of the system.

According to the information collected from respondents of the semi-structured interview, almost all definitions of an RIS included institutional aspects, as for example, the "articulation of different elements" is highly associated with the informal institution called "interaction and collaboration", which was also listed by the interviewees among the most important informal institutions for the RIS. The second most popular definition in which the system is considered a "network platform" is related to the formal institution identified as "value networks", while the third and fourth; "system to support society welfare" and "mechanism to create and support innovation culture" are associated with the informal

institutions of "social innovation orientation" and "innovation supportive culture". The stronger presence on informal institutions in the definitions of an RIS must be noted.

In relation to the reasons to participate in an RIS, it is interesting to see that most popular answers among all four types of actors were pointing towards commitment, contribution to the RIS and networking, while those related to get advantage of the system were not shared by so many actors (e.g. as a way to identify capabilities and opportunities, for the access to financial support and mentoring, and for education and training access). This finding needs further revision in the future, as it might be seen, a priori, as an altruistic way of thinking that places first the ways to contribute and support the system, but it can contrariwise indicate a failure of the RIS at the moment of materialize and communicate the advantages offered by the system and the valuable resources available for the participant organizations.

In other respects, when exploring the formal institutions, the one that participants identified the most is the investment, incubation and acceleration. Those three activities were kept together in a single code as they were consistently mentioned together, and they all involve financial and human support to nascent or immature innovation projects. It is important to notice that these kind of activities, which are related to the availability of resources to support innovation, can be offered by governmental agents as well as by private firms or even by individuals with the capacity to do so. Furthermore, when examining the role of formal institutions, it was interesting to find that informants mentioned institutional factors linked to both private and public actors to the same extent, what means that regulation and formal structure for IP is being seen as a responsibility of both governmental and non-governmental organizations.

It is also important to note that various interviewees mentioned the importance of distinguishing between those formal institutions that should be oriented to the long term and

those that should be oriented to the short term. According to the information collected, long term oriented (LTO) formal institutions are those related to policies and plans at a regional and national level in regarding the importance given to innovation in the economy, as well as the governmental commitment on investing in sustaining the institutional framework required to encourage innovation and on supporting the innovative performance of the RIS. This means that this kind of institutions should remain consistent, even when there are politic changes or when new politicians are elected to govern, avoiding the instability that usually comes with every political election period.

In contrast, short term oriented (STO) formal institutions, should be those intended to regulate the details of the economic transactions, property rights, licenses, permits, relations among agents, among others, as the concept of innovation have the rapid change implicit on it. According to informants, when the innovation practices are evolving faster than the innovation regulations and laws critical imbalances occur, and the impossibility of regulations to catch up with the changes on real scenarios discourages the fluid process of innovation creation, prototyping, testing, scaling and diffusion. It is important to clarify that this does not mean that the LTO institutions should remain static, or maintain unalterable forever. These institutions are expected to be applicable for long periods but should also evolve or change when they are no longer efficient. Similarly, even though STO institutions may evolve at the pace of innovation activity, they should remain clear and effective, and efficient communication means should be designed to divulge them, as fast change might not lead to institutional uncertainty or ambiguity. As Van Waarden (2001) said, economies are more innovative when their regulatory schemes are truly efficient in decreasing instability, uncertainty and risk.

On the other hand, when exploring informal institutions, the innovation supportive culture, as the level of acceptance innovative activities, innovation and creative thinking, was

identified by most of the interviewees as crucial for the IP of the RIS. It is arguably that innovation culture could be defined as an umbrella construct, composed by a sort of particular informal institutions (e.g. risk taking, entrepreneurial orientation, tolerance for failure, perseverance, ambition, among others), but for this case, participants of the study clearly differentiated innovation culture from other informal institutions and the decision in the final structure was to consider it apart. Nonetheless, given the importance assigned to innovation supportive culture by the subjects of the study, it is pertinent to recommend that future research examine the concept of innovation culture, understanding the corresponding factors and how to appropriately embed it in the institutional framework analysis.

Secondly, in reference to the informal institutions, it is interesting to see how regional identity and global vision, were both mentioned within the top five important informal institutions, which might seem contradictory in a certain way. However, the interviewees stated that the exchange between actors belonging to different systems has a positive influence on innovativeness, precisely because there are intrinsic differences between the actors allowing the creation of novel ideas, new ways of collaborating, thinking, generating and transferring new knowledge. This is in consonance with Kaufmann and Tödtling (2001), who said, "the key advantage of engaging in external relations for realizing innovation projects is based on diversity, by linking up to different systems instead of remaining within a system's set of routines" (p. 791).

It is also interesting to notice that religiosity in relation to IP, is a variable widely studied in regard to individuals, but it is an institution that nowadays has permeated different scenarios, currently appearing as a flag for conservative governments as well as the main discourse in universities and educational organizations. For this reasons, it would be interesting to study the variable in the future, comprising a greater scope than the individual

does, for example comparing IP levels of RIS embedded in conservative-religious governments versus those presented in the context of liberal-secular governments.

Concerning the analysis about the influence of institutions over IP, in accordance with Lee and Law (2016; 2017), the impact of the institutional framework on innovation might be in some cases positive but also restrictive in others. Along with the examination of institutional aspects positively influencing the IP of an RIS, five main factors were identified, which lead to the formulation of the following hypotheses to be operationalized and tested in future research:

*H*1: Higher levels of innovation culture within an RIS are related to higher IP levels.

*H*2: The quality of education and training systems for people and organizations within an RIS is positively associated with IP levels.

*H*3: The well-functioning of public innovation intermediaries in an RIS, exerts a positive impact over the IP of the RIS

*H*4: Higher levels of entrepreneurial orientation are associated with higher levels of IP.

*H*5: The better the mechanisms of knowledge transfer within an RIS, the higher the level of IP.

As innovation performance has been subject of many previous studies (e.g. Hermans, Klerkx, & Roep, 2015; Kim, 2014; Najafi-Tavani et al., 2018; Wang, et al., 2018; Zhao et al., 2010), the variable has been widely operationalized and it is possible to be measured in the future using similar procedures to those used by Chang (2003), Paas and Poltimäe (2010), Serrano-Bedia et al. (2017), and Vega-Jurado et al. (2009). In addition, the IP of the whole RIS can be measured as the sum of the innovation outputs of the agents acting within the system (Cooke et al., 1997). For the case of the variables related to institutional factors, it is necessary to make an appropriate literature review and systematically define how to estimate

or measure them, in order to proceed to their forthcoming study and hypothesis testing. It will be also the case for the hypotheses about the factors negatively influencing the IP of organizations of the RIS, which are:

H6: Lower levels of market orientation are related to lower levels of IP in the organizations of an RIS.

H7: The lack of clarity in roles of public innovation intermediaries is associated with lower levels of IP.

H8: More constraining statutes and organizational rules are associated with lower levels of IP in the RIS.

H9: Bureaucracy and legal complexity in an RIS, exert a negative impact over the IP of the RIS.

H10: The higher the uncertainty avoidance level of the society the lower the IP level within the RIS.

It is important to observe that respondents identified the public innovation intermediaries, as one of the main factors positively influencing IP of the organizations within the RIS, but also as a factor, that in certain contexts, could exert a negative effect over the IP. Rivera et al. (2011) said that a crucial role of public agents in the actual multicultural knowledge economies is the coordination of actors within the IS. Besides, the study of Klerkx and Leeuwis (2008) revealed numerous positive influences from innovation intermediaries, but they also recognized those contributions are yet unmeasured and therefore additional quantitative and qualitative systematic analyses of the effect of innovation intermediaries on IP are desirable. In contrast, as reported by Klerkx and Leeuwis (2008) problems in the operation of innovation intermediaries, might occur when there are blurred imageries of innovation intermediaries' functions and perceptions of incoherent policy when establishing innovation intermediaries. Considering this findings, future research might address the

function of innovation intermediaries, to understand which one is the core role that those organizations want and should play in the system, recognizing that by definition they can be either public or private entities (Klerkx & Leeuwis, 2008). As reported by Watkins et al. (2015) private innovation intermediaries in form of industry associations "may offer valuable insights to how institutional capacity building occurs and how it might be directed, particularly in the context of developing countries where governance capacities are often lacking" (p. 1407).

Regarding the type of institutions (formal or informal) with greater influence over IP, according to the information provided by participants, the informal institutions have a crucial role for the IP of RIS, as most respondents declared they exert a greater effect over the RIS´s IP levels than the formal ones. This coincides with Rauf (2009) who said, "In most developing countries where the formal institutional architecture is either absent or in poor state, the informal institutions gain prominence for playing a more active role in economic activity" (p. 25). Additionally, Hitt and Salmador (2013) indicated that the most important dimensions of a country's culture decisively influence the evolution and development of the formal institutions. This result is even more meaningful considering that traditionally, most of the academic articles about the relation between innovation and institutions, has emphasized on the role of formal institutions (Lee & Law, 2016; Tebaldi & Elmslie, 2013) rather than on informal institutions (Lee & Law, 2017). This finding led to the following hypothesis for future research:

*H*11: Informal institutions exhibit a greater effect over IP levels of an RIS than formal institutions.

There is yet scarce information regarding the differentiated impact of formal and informal institutions over the IP, and in the study of Lee and Law (2016) the conclusions indicated no unique differences between the influence of formal and informal institutions on

the IP levels at a national scale. This result is contrary to what findings of present research suggest and this is why one recommendation for future research is to test of the emergent hypothesis of this study.

However, it is noteworthy that all subjects included in the study recognized that the institutional environment, including formal and informal institutions, affects innovative outcomes of the actors in an RIS, and for these reasons the different types of institutions should be complementary in promoting country and system innovation performance. The informal institutions, in form of competences, capabilities, attitudinal and behavioral factors, influence the interaction and the quality of social relationships, economic cooperation, knowledge transfer and implementation of policies. In addition, formal institutions are a result of social evolution and emerging needs, so the risk of inconsistency is lower when the changes in the formal framework of a system are in harmony with the inherent transformation of the society's culture, values and customs.

Finally, regarding the segmented analysis, results demonstrated when intervening the institutional framework, policy makers and institutional entrepreneurs must acknowledge the differences among the interests of the diverse actors of the quadruple helix, as the relevant institutions for each actor are not equal. In the category of informal institutions, the innovation supportive culture is the most important for all types of actors, but afterward there are different interests associated with the core expected functions of each actor. University actors were more focused on the informal institution of innovation knowledge and skills, industry actors recognized the relevance of human capital for IP, governmental actors remarked the importance of social innovation orientation, while participants from civil society highlighted their own role for the IP, consistently declaring the civic entrepreneurship as one of the most important informal institutions.

In addition, when examining the relations among the different themes in the segmented analysis, consistency was found in the information provided. It was possible to observe that for industry representatives, the human capital resulted to be one of the most relevant informal institutions, and these participants also highlighted how education and training systems positively influence the IP, as they account for the training of their firms' future personnel, which is the human capital. Informants from the government side identified the social innovation orientation as an important informal institution, while additionally recognized the innovation supportive culture as a crucial institutional factor affecting IP, being those two factors closely related. The university representatives were more focused on the improvement of innovation knowledge and skills, claiming that knowledge transfer exerts a positive influence over IP. Both institutions are interrelated, as knowledge transfer is required when training personnel, creating new knowledge and developing innovation skills in human capital. Finally, interviewees from civic associations identified the civic entrepreneurship as an important factor for IP, and further mentioned the expected positive influence of the well-functioning of public innovation intermediaries and of the innovation supportive culture, which are two important institutional factors enabling civic entrepreneurship (Etzkowitz, 2015).

The empirical results of this study have significant managerial and policy implications. As participants constantly manifested the unfavorable effect of the unclear roles of innovation intermediaries, the generation of an articulated institutional framework accompanied by pertinent innovation intermediaries with clear roles and transparent functions, should be a crucial policy focus. Also, legal environment continues to be very significant when simulating or obstructing IP, and according to respondents, there are four main concerns about laws and regulations: 1) they should motivate innovation, 2) they should

be easy to understand and apply, 3) they should help to protect the innovative firms and create confidence, and 4) they should respond to reality and rapidly change when necessary.

With regard to the organizations pursuing IP, according to findings there is a need to understand the importance of market orientation when ideating, planning and executing innovation projects, as well as bear in mind the significance of internal statutes and organizational rules for the accomplishment of IP goals. As uncertainty avoidance hinders IP, organizations pretending to achieve high levels of IP should be more oriented towards risk taking, and likewise they should encourage this habit in their employees, by and increased tolerance for failure. Universities, academic entities, and research centers also play an important role for IP according to the participants, since they have an important part on training, education, entrepreneurial orientation, and knowledge transfer, all factors being identified as very important for the IP in the RIS. Even though all actors from quadruple helix are involved in one way or another with the innovation supportive culture, civic associations are especially relevant, as they are an expression of that supportive culture and at the same time help recreate and develop the innovation culture in the society.

One of the key findings of the study, which is the perceived greater effect of informal institutions on the innovative activity and performance, also suggest that institutional entrepreneurship and strategies might be tailored considering the specificity of regional settings and cultures. Innovation performance as described by subjects of the study seems to be more a social value than an economic value, as it has been traditionally depicted, so strategies designed according to the institutional differences of regions are expected to yield superior results than otherwise. This also implies that the building and improvement of the formal institutional framework should respond to the explicit needs and demands of the actual and potential economic actors of the system. In the end, well-functioning institutions provide innovation promotion derived from government policies and plans, proper financing

mechanisms for innovation, regulation supporting the protection of innovation and intellectual property, pertinent human capital as a result of high-quality educational institutions, and mechanism to build innovation supportive culture trough cultural transformation programs.

Finally, there are some other interesting conclusions from the data analysis, which are worth to discuss. As specified by Etzkowitz and Ranga (2015), functions for each actor of the quadruple helix model have been traditionally specified, as for example wealth generation corresponds to the industry; novelty production to the university; and public control to the government. However, findings of the present study are in line with the contemporary vision about the blurred limits among the roles, functions and objectives of the different types of actors in the context of non-linear dynamics.

The government, the industry, the university and the civil society are now expected to perform duties that were traditionally realm of other types of actors. Private firms are actively transforming the political scenarios and participating in governmental decisions; universities and governmental parties are acquiring more entrepreneurial roles, civic associations are creating and transferring relevant knowledge, and new modes of university-industry-government relations are taking place. As explained by Etzkowitz (2012), the possibility to switch roles and the ability of individuals to circulate from one sphere to another, enhance interaction capabilities and vitalize the activity of the RIS.

As a final note, it is significant the observed lack of knowledge about the difference between institutions and organizations within the RIS, even more considering that interviewees were not only highly related to the innovation concept but also to the innovation activity of the system. More than that, when performing the literature review, it was found that in some rare cases, in recent academic articles the authors incorrectly used the term 'institution' referring to governmental agencies, private firms and academic institutes, which

should be identified as organizations (e.g. Cavanagh & Thompson, 2018; Manyuchi, 2018; Ngoc-Tan & Gregar, 2018; Romero, Suarez, & Rodriguez, 2018; Yun et al., 2017). It usual for individuals to confuse institutions with organizations, regardless the importance of realize this distinction, especially for researchers, for policy makers within the RIS and for those agents involved in institutional entrepreneurship and institutional change for innovation.

This thesis is an initial work, as the first step in a more ambitious plan to further develop the instruments to test the emergent hypotheses, and is the base for a series of longitudinal studies to observe changes in institutional frameworks of different RIS and their impact over the IP, seeking to consolidate a robust theory in the future.