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# Towards a functional governance framework for regional innovation systems in emerging economies: the case of Risaralda (Colombia)

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## ABSTRACT

The analysis of Regional Innovation Systems (RIS) in Latin America has grown from both academic and policy perspectives. However, the dominant structural approach on RIS has limited the scope of analysis, overlooking the functional dynamics that take place in such systems. This paper addresses the question of *how to conceive the governance of RIS from a functional perspective*, by conducting a case study on the emerging Risaralda RIS (Colombia), which stands out for its innovative performance while still displaying important systemic failures. We specifically inquire into the strengths, weaknesses, integration dynamics and functions of this RIS. Results show a system with institutional and governance failures, which is host to a disperse network of stakeholders and innovation processes that include prioritized and enabling functions. We discuss these results and propose a governance framework that was collectively outlined with the participation of stakeholders in the RIS of Risaralda.


## KEYWORDS

Regional innovation systems; innovation governance; systemic functions; systemic failures; Risaralda

## 1. Introduction

The analysis of Regional Innovation Systems (RIS) in Latin America has considerably evolved, acquiring new shades given the specific features of its context and the implications of political systems in the region for the concept itself. However, literature agrees on the need to further academic and policy operationalization of the concept and to account for the functional dynamics of RIS, beyond its structural elements.

In this regard, some relevant contributions from regional multilateral organizations include methodologies to analyse Latin American RIS (see Montero and Morris 1999 from ECLAC<sup>1</sup>) or compilations of several cases in countries of the

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region, reflecting on the implications of the concept of RIS in the Latin American context (see Llisterri, Pietrobelli, and Larsson 2011 from IDB<sup>2</sup>). Other Latin American analyses propose RIS typologies (Godinho, Mendonça, and Pereira 2004; Valdez-Lafarga and León-Balderrama 2015; Niembro 2017; Bernal-Perez 2018), with regard to two main topics: first, regional development, highlighting the regional gaps within countries where capital cities hold a concentration of innovation capabilities. Second, regional political-administrative arrangements, which typically have shaped RIS as a unit of analysis.

The cases of Mexico (e.g. Dutrénit 2009; Garza and Espinosa 2015; Valdez-Lafarga and León-Balderrama 2015), Argentina (e.g. Pasciaroni 2015; Niembro 2017) and Brazil (Matos et al. 2017) have the most studies on the topic, which stress the importance of RIS as a basis for local development. For instance, in Brazil the work builds on notions such as RIS and local productive arrangements in order to contribute to a more contextualized understanding of how innovation contributes to regional development, especially in a complex environment of globalization (Matos et al. 2017). Likewise, in Argentina some have analysed how local innovation systems can be better harnessed as an operational mechanism for regional development (Yoguel, Borello, and Erbes 2009).

Nevertheless, the analysis of Latin American RIS has had a normative and structural bias (Arocena and Sutz 2001). It has determined the suitability of this regional case notion based on successful experiences in other developed countries (Llisterri, Pietrobelli, and Larsson 2011). Further theoretical reflection is needed,<sup>3</sup> as well as more empirical studies in Latin America in order to inquire into the innovation capabilities of local stakeholders and policymakers, regarding their own context (Morales, Ortíz, and Arias 2012; Cummings 2007). This implies moving from structural RIS analysis towards a more critical functional analysis, focusing on the multiple processes that explain the innovation performance at the regional level, in a context of increasing regionalization of innovation policies (Llisterri, Pietrobelli, and Larsson 2011).

In this regard, and inspired by other Latin American analyses (e.g. Matos et al. 2017), we ask: *how can the governance of RIS be conceived from a functional perspective?* with the purpose of contributing to broaden the analysis of RIS within the systemic functions framework (Hekkert et al. 2007) for the case of intermediate territories in emerging economies of the Global South.

To do so, we analyse in detail the case of Risaralda (Colombia), a state with an emerging RIS that illustrates how some of the challenges of Latin American RIS are associated with governance failures that restrict the harnessing of their innovation capabilities (Kuhlmann and Ordóñez-Matamoros 2017). A more functional governance of RIS is needed, so we propose a governance framework that contributes to enhancing the quality of the RIS in the case of Risaralda.<sup>4</sup>

The paper is structured as follows: section 2 synthesizes the theoretical framework that guided this research, based on the RIS concept and systemic functions framework. Sections 3 and 4 present the methodology and results of the analysis, respectively, deriving lessons learned from the case of the Risaralda RIS. Section 5 discusses the results, deriving lessons from the case. Finally, section 6 proposes a functional governance framework for the Risaralda RIS, as well as some final remarks potentially extensible to the case of other similar cases in Latin America.

## 2. Theoretical framework

The concept of Regional Innovation Systems (RIS) is based on the systemic approach on innovation, which deals with the incidence of stakeholders, interactions and institutional arrangements<sup>5</sup> on the innovation process (Freeman 1987; Lundvall 1992; Nelson 1993; Edquist 1997). The notion of RIS includes analytical variables such as proximity, physical space and territorial institutions to complement the systemic approach in terms of scale and complexity of innovation processes (Cooke, Gómez Uranga, and Etxebarria 1997; Buesa et al. 2002).

A RIS is a ‘set of networks of public/private stakeholders that interact and give feedback within a specific territory, harnessing local infrastructure for the purposes of adapting, generating and diffusing knowledge and innovation’ (Buesa et al. 2002, 16), where proximity enables better interactions. RIS are comprised of ‘subsystems of generation and use of knowledge that interact and are linked to other regional, national and global systems, for the commercialization of new knowledge’ (Cooke, Ropeer, and Wylie 2003; in Llisterri, Pietrobelli, and Larsson 2011, 10).

In addition to their structural components, multiple processes take place within innovation systems (IS) known as systemic functions (Hekkert et al. 2007; Bergek et al. 2008). This functional approach has emerged in response to the deterministic and static character of the structural approach on IS, and focuses on the roles that enable the central objective of an IS: to promote innovation processes, i.e. to develop, diffuse and use innovations. Particularly, these systemic functions (Hekkert et al. 2007):

- *Promote entrepreneurial culture* by acknowledging growth potential and identifying technological and business opportunities;
- *Promote knowledge development* in order to support production and use it for innovations;
- *Facilitate knowledge and information diffusion between stakeholders*, as well as constant learning;
- *Guide the search for resources* by leading the mobilization of private resources towards defined priorities;
- *Boost market formation and environments for applying innovations* with mechanisms to protect innovations in their early stages, so they can reach sufficient maturity for open market competition;
- *Provide human and financial resources*, with direct public investment in appropriate infrastructure for the production of goods and services; and
- *Counteract resistance to change* with mechanisms of promotion, and legitimation of innovations and innovation culture.

That said, the possible challenges that affect the performance of IS, whether at the national or regional level, imply the intervention of governments focused not only on individual organizations or their interactions but on the whole system by addressing systemic failures (Woolthuis, Lankhuizen, and Gilsing 2005). This requires systemic or ‘holistic’ innovation policy instruments to boost the functions of a RIS (see a list of instruments in Smits and Kuhlmann 2004; Wiczorek and Hekkert 2012; Borrás and Edquist 2013).

Achieving an ‘operational’, effective and efficient RIS, like the one suggested by the above-described elements, implies governance frameworks that account for the specificities of the context (Llisterri, Pietrobelli, and Larsson 2011), which is: enabling institutional arrangements<sup>6</sup> for innovation governance, considering the influence that institutions have on the innovation process and the interactions between stakeholders and organization in a IS (Freeman 1987; Edquist 1997). These interactions should also ensure coordination in both vertical and horizontal terms, i.e. between innovation policy and local problems, and between innovation policy and other sectoral policies, respectively (Chaminade and Padilla-Pérez 2017). These institutionalized interaction patterns are, for instance, resource mobilization within the system, the supply of supporting services for innovation, intermediation to facilitate dialogue between stakeholders and the transfer of knowledge, among others (Kuhlmann and Arnold 2001).

### 3. Methodology

Considering the overarching research question stated before as to *how can the governance of RIS be conceived from a functional perspective?*, and building on Yin (2003), we conducted a qualitative and exploratory case study on the Risaralda RIS. This, based first of all on the kind of sub questions framed which stress the explanatory purposes of the study. This, in turn, allows us to derive propositions to advance on the research and understanding of RIS in general, and its main governance challenges in particular. Specifically, we ask: *what are the characteristics, strengths and weaknesses of the Risaralda RIS? How and to what extent is the Risaralda RIS functionally integrated? How does the Risaralda RIS contribute to developing, diffusing and using innovations by means of systemic functions? What are the main challenges and opportunities for the implementation of an innovation governance framework based on systemic functions in the case of the Risaralda RIS? With the previous in mind, what can be learned from the Risaralda RIS case?*

Secondly, we address the complexity of a contemporary phenomena such as an emerging RIS, based on direct observation by the authors and the workshops held with stakeholders (Yin 2003). This paper builds on the information and experience of three of the authors who participated in a research project on this topic in 2017 (see acknowledgements). Therefore, the paper brings together academic knowledge starting with information that was initially gathered and used for a complementary purpose. A reflexive and contextualized perspective is taken on this. This methodological approach allows us to dig deeper into the specific features of the individual case (Risaralda RIS) in its own context and to draw generalizable findings from the sources of information available (Gerring 2007).

Gathering the data implied mapping, systematizing, and characterizing a database of 139 stakeholders of the Risaralda RIS, including state and municipality governments, planning and economic development officials, higher education institutions, firms, research groups and chambers of commerce, among others. This database was built on the suggestions of the Regional Competitiveness Commission, the participants in calls for open workshops, members of the monitoring committee work team of the above-mentioned project. The saturation curve for the identification of stakeholders was reached when we noticed the frequency with which new suggestions of stakeholders

already included in the database were repeated, as usual in snowball sampling methods (Naderifar, Goli, and Ghaljaie 2017).

An information-gathering instrument was applied to the stakeholders identified, inquiring into (a) the subsystem to which each stakeholder belonged according to their perception (see Table 1), (b) the type of relationship that each stakeholder held with others within the RIS (see Figure 1), and (c) their perception on the systemic functions of the RIS.

The first aspect (a) allowed us to characterize the composition of the Risaralda RIS from a structural perspective, as well as the magnitude of each subsystem (Llisterri, Pietrobelli, and Larsson 2011) according to the number of stakeholders self perceived as belonging to each. These subsystems were defined and exemplified for each stakeholder to provide a response based on it (Table 1). This question was only applied to a sample of 50 stakeholders due to information access limitations in the early stages of the data gathering process.

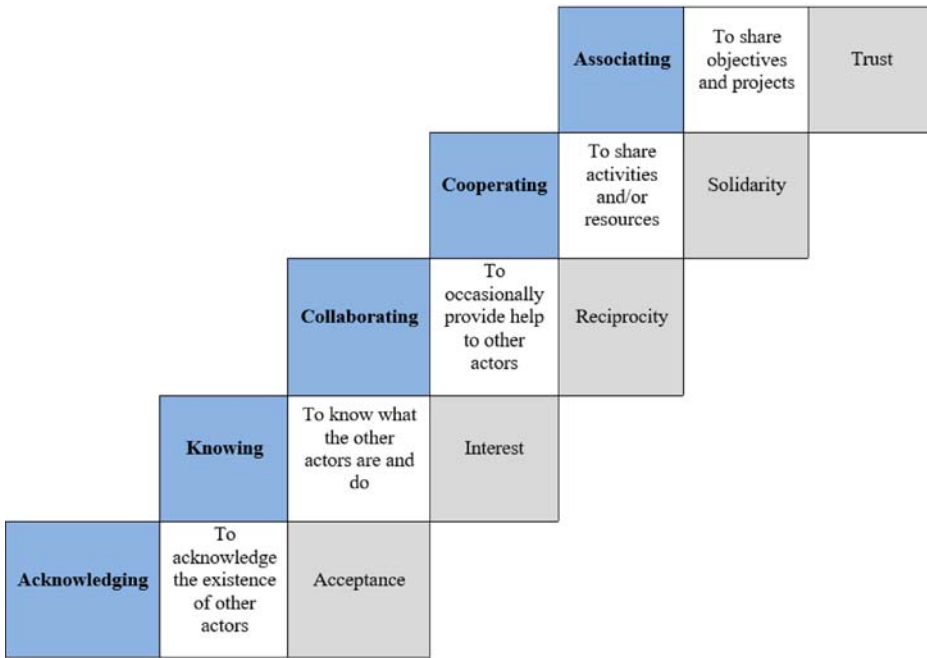
The second aspect (b) allowed us to map the amount and quality of interactions between stakeholders (Orozco 2004), based on the scale of relationship intensity of Rovere (1999) (Figure 1). With this, we conducted a social network analysis, displaying the network graph for the Risaralda RIS (Figure 4), and measuring the degree centrality for each stakeholder, accounting for the importance of these stakeholders within the network (see Appendix 1).<sup>7</sup> The intensity of the interactions is represented by the thickness of the links on the graph, where relationships based on trust are those displaying the widest links.

The third aspect (c) allowed us to analyse the systemic functions of the Risaralda RIS (Hekkert et al. 2007; Bergek et al. 2008). We looked at the perception of stakeholders in the RIS concerning these functions with three specific questions: (i) are any of these functions present in the RIS? (ii) does the stakeholder contribute to the development of any of the functions? and (iii) what functions need to be strengthened? For each question the stakeholders provided a rating on a scale of 1–5, 1 being the lowest rating and 5 the highest.

**Table 1.** Subsystems in the Risaralda RIS.

Subsystem	Definition and examples
Institutional	Local and national decision makers and officials with impact at the local level, e.g. municipality, parliamentarians, ministry, governors, etc.
Financial	Public and private funding organizations of science, technology and innovation, e.g. governments, banks; venture capital funds; international funds; cooperatives, crowdfunding, entrepreneurial managers for tax incentives
Societal	Non-profit organizations and users of knowledge, e.g. civil society organizations, hospitals, schools, NGOs, intergovernmental organizations, family compensation associations, labour unions, media, museums, etc.
Interface	Facilitators for knowledge and technology transfer, e.g. knowledge and technology transfer offices, consultancy firms, libraries, information services, indexed journals, etc.
Scientific	Knowledge users and producers, e.g. research institutions and groups, higher education institutions and universities, knowledge and innovation intensive firms, etc.
Technological	Producers, users and facilitators of technological developments, e.g. technology parks, technology company incubators, centres for productive and technological development.
Entrepreneurial	Knowledge users with profit purposes, e.g. firms, guilds, entrepreneurial associations, commerce chambers, etc.

Source: Adapted from Llisterri, Pietrobelli, and Larsson (2011).



**Figure 1.** Scale of relationship intensity. Source: Rovere (1999).

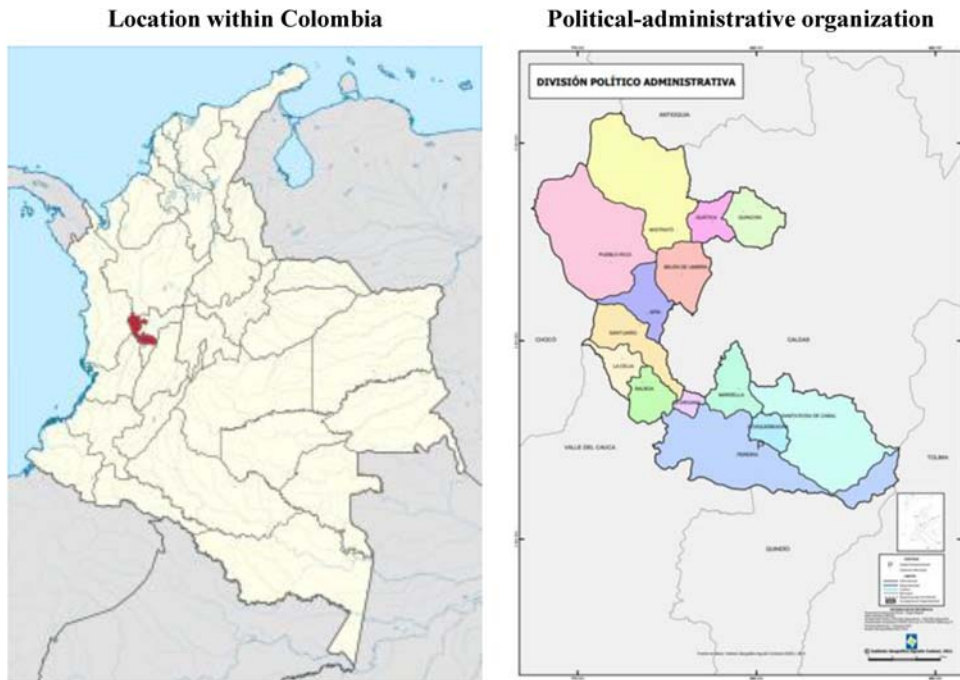
Additionally, six workshops were conducted between April and June 2017, with the participation of 266 people (see [Appendix 2](#)). Here, discussions were held following guiding questions, allowing to better understand the perceptions of stakeholders concerning the progress of the project and, by doing so, jointly co-designing the governance framework for the Risaralda RIS. This process was guided by the categories described in the theoretical framework. This application allowed us to draw a relevant governance framework for Risaralda, including original contributions by the participants.

## 4. Results

In this section, we present the case of Risaralda, the structure of its RIS from the perspective of its stakeholders, as well as the functions that they develop. This is presented based on the research questions formulated in the previous section.

### 4.1. The case of Risaralda

Given its cultural and geographic features,<sup>8</sup> Colombia is a country with well-differentiated regions in which growing political decentralization has enabled the regionalization of innovation policies and the emergence of RIS (Moncayo 2018). Such is the case of Bogotá, D.C. (Calderón et al. 2016), Atlántico (Ortiz 2012), Valle del Cauca (Caicedo 2012), Santander (Arias et al. 2013), or Antioquia (Jiménez, Fernández de Lucio, and Menéndez 2011; Cote-Peña et al. 2016). However, regional innovation measurements show wide gaps between territories, with some states, as previously mentioned, standing out above the others (DNP and OCyT 2019).



**Figure 2.** Map of the State of Risaralda. Source: Instituto Geográfico Agustín Codazzi – IGAC.

In this context, we ask *what the characteristics, strengths and weaknesses of the Risaralda RIS are*, a state with a remarkable innovative performance. Located in the Andean region of the country and comprising 14 municipalities (see Figure 2), with a population of over 960,000 and an economy based mainly on commercial activities, manufacturing and agriculture, Risaralda is an illustrative case of an ‘emerging’ RIS, i.e. ‘where most part of organizations are present, but the critical links and institutional frameworks to facilitate innovation are weak and fragmented’ (Cummings 2016, 85).

The strengths of the Risaralda RIS are found in its own business environment, Information and Communications Technologies (ICTs) infrastructure, human and research capital, its capacity for knowledge absorption, and creative output (DNP and OCyT 2019). Risaralda has achieved an efficient performance by transforming its available inputs into better innovation outcomes, reflected in regional competitiveness<sup>9</sup> and innovation<sup>10</sup> rankings, placing 5th and 6th out of 33 states in Colombia (including the Capital District), respectively. This coincides with a growing institutionalization of its RIS since 1994, with more policies to foster the contribution of innovation to regional competitiveness.

Nevertheless, according to some local stakeholders and the policy and academic documents we consulted, there are still systemic failures concerning the institutional frameworks and governance capacity of the RIS (see Aguilera 2014; Plan Departamental de Ciencia, Tecnología e Innovación – PECTI de Risaralda 2010). These failures are linked to the difficulty in consolidating sustainable (over time) governance frameworks due to the discontinuity generated by constant governmental changes. This translates into a weak capacity to build a RIS that produces, transfers and integrates scientific and technological knowledge into solving territorial productivity, environmental and



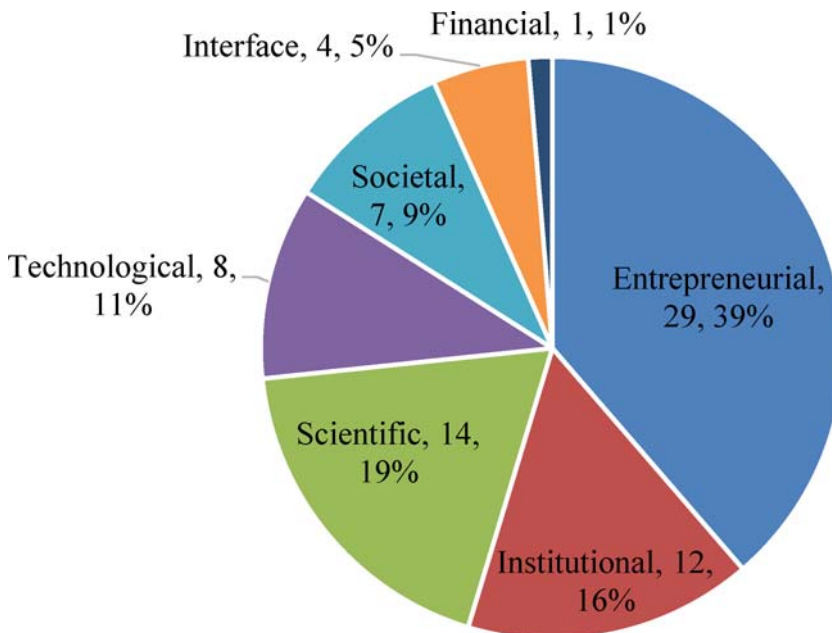
societal problems.<sup>11</sup> Overall, a weak capacity and structure to achieve a relevant RIS persists, with a low level of innovation funding, social appropriation of innovation, major challenges regarding the production of knowledge and technology, and a weak market sophistication (DNP and OCyT 2019).

Finally, it is necessary to clarify that even though the Risaralda RIS – as any other RIS – transcends territorial political-administrative boundaries, we studied the case under these limitation considering that this is the scope of action of the regional government. Its scope being primarily to guide the design, implementation, monitoring and evaluation of a functional innovation governance framework, typical in emerging economies like the one under study, where governments play a central role (Cooke, Gómez Uranga, and Etxebarria 1997). Therefore, a minor caveat is that this analysis may exclude some possible processes and interactions between stakeholders that extend beyond the borders of the Risaralda State.

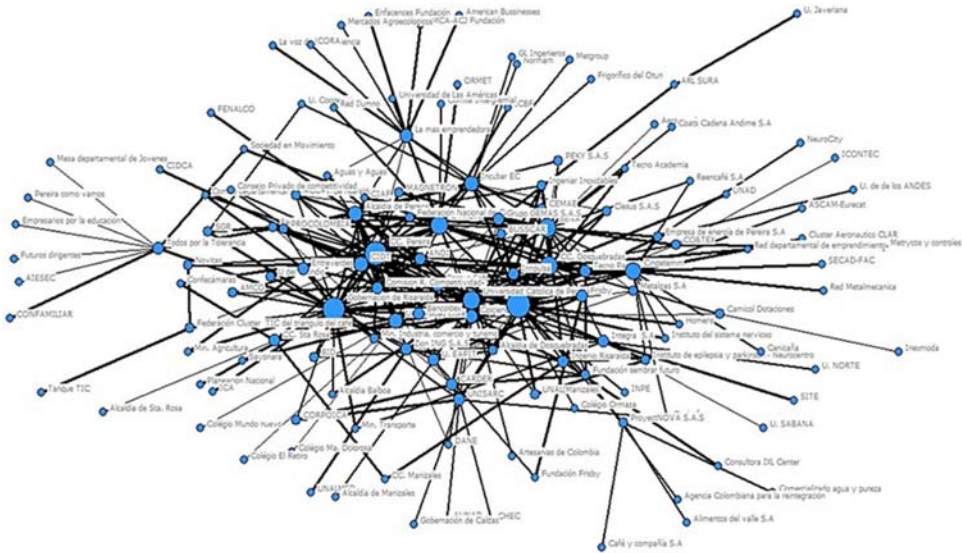
#### 4.2. Stakeholders and interactions in the Risaralda RIS

Regarding *how and to what extent the Risaralda RIS is functionally integrated*, the sample of 50 stakeholders in the RIS shows the composition of its subsystems (Figure 3). We found a prevalence of entrepreneurial, scientific, institutional and technological subsystems, and a smaller size of the societal, interface and financial subsystems given their recent emergence in innovation agendas in Colombia and Risaralda.

For the case of the 139 stakeholders identified, we investigated the type of relationship that each stakeholder held with the others within the RIS. Figure 4 shows the



**Figure 3.** Stakeholders in the Risaralda RIS subsystems ( $n = 50$ ). Source: Work team of the ‘Gestión del Sistema Regional de Ciencia, Tecnología e Innovación’ Project (2017).



**Figure 4.** Stakeholder network of the Risaralda RIS ( $N = 139$ ). Source: Work team of the ‘Gestión del Sistema Regional de Ciencia, Tecnología e Innovación’ Project (2017).

intensity of these relationships represented by the thickness of the links and the relevance each stakeholder represented by the size of each node according to their degree centrality (i.e. the number of links for each node) (see Appendix 1). While the average of links per stakeholder within the network is 16.7 (average degree) (see Table 2), the highest number of links is 140 and the lowest is 2 (see Appendix 1). This contrast shows that there are a few stakeholders that are effectively integrated. Here, universities stand out as central stakeholders within the network by intermediating between actors of the RIS.

We also observe that the network is rather disperse and has a low density, given the small amount of stakeholders that are interconnected coupled with the proportion of links over the potential interactions (12.1%) (Figure 4). The discussions held in the workshops suggest that this is due to the lack of trust between stakeholders for interacting, cooperating and associating (Wieczorek and Hekkert 2012), as well as the absence of clear institutions (‘rules of the game’) that prevent any power asymmetry in interactions in which some stakeholder has a dominant position over the others.

Furthermore, most stakeholders in the network interact with less than 10 stakeholders, and interactions are concentrated within a small group (Appendix 1). Consequently, and in spite of its relative small size, stakeholders in the Risaralda RIS tend to have two main

**Table 2.** General social network metrics for the Risaralda RIS.

Indicator	Value
Network size	139
Average degree	16.71
Network density	0.121

Source: Work team of the ‘Gestión del Sistema Regional de Ciencia, Tecnología e Innovación’ Project (2017).

interaction patterns: first, few but strong interactions, which correspond to stakeholders that have stable links with a small group of organizations concerning strategic objectives; second, numerous but weak interactions, involving organizations with innovation diffusion roles. We will expand on this finding in the discussion section.

### **4.3. Systemic functions in the Risaralda RIS**

To better understand *how the Risaralda RIS contributes to developing, diffusing and using innovations by means of systemic functions, and what the main challenges and opportunities for the implementation of an innovation governance framework based on systemic functions are in the case of the Risaralda RIS*, we examined the perception of stakeholders concerning systemic functions in the territory (Hekkert et al. 2007).

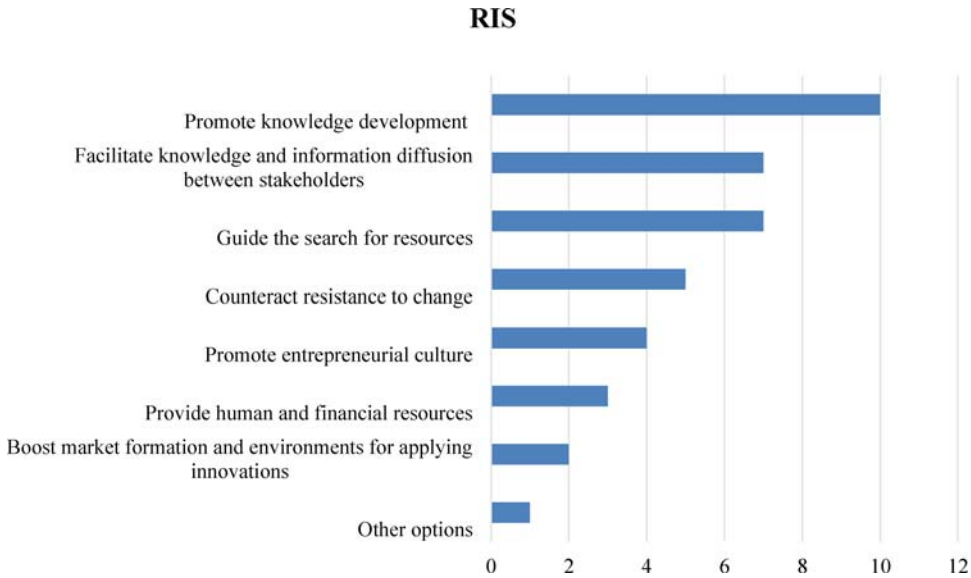
Firstly, regarding the presence of the functions in the RIS, the stakeholders tended to rate this as 3, meaning that there is a balanced presence of functions in the territory. Even though none of the functions are specifically highlighted, knowledge development, entrepreneurial culture and the provision of resources seem to be considered slightly more present in the territory. In contrast, market formation and counteracting resistance to change seem to be less present.

Secondly, the question of which function is developed by each stakeholder suggests a more reflexive perspective. Here, respondents stressed their contribution to any of the functions, even if not in a high degree. Stakeholders have a higher perception of their contribution to functions in contrast to a lower perception of the presence of functions in the RIS, as suggested in the previous question. This shows their willingness to supply services for each function, which could inspire possible governance arrangements to harness their capacity and willingness regarding systemic functions, specifically concerning entrepreneurial culture, knowledge development and knowledge and information diffusion.

Thirdly, concerning what functions need strengthening in the RIS, we observed a prioritization of functions such as the promotion of entrepreneurial culture, knowledge development and knowledge & information diffusion. According to stakeholders, these functions can be prioritized over the others because they have a higher degree of governance and are more feasible to manage. Therefore, the remaining functions can be considered enabling functions since, in spite of being as important as the prioritized ones within the system, they are necessary but not sufficient and their governability can be enhanced with better performances by the others. This suggests a possible 'hierarchy' in systemic functions, which will be further addressed in the discussion.

Additionally, during the workshops with stakeholders a list of challenges and needs of the RIS was jointly elaborated, and we questioned which systemic functions could contribute the most to addressing these challenges. This showed that the functions of knowledge development, knowledge & information diffusion and guiding the search for resources could better impact addressing the challenges, needs and opportunities of the RIS (Figure 5).

Finally, stakeholders highlighted that there is a need for further promotion of entrepreneurial culture in the technological, entrepreneurial and societal subsystems, and to do so, more resources must be provided by stakeholders in the financial subsystem. Additionally, the function of facilitating knowledge and information diffusion was identified as relevant for stakeholders, evidencing their willingness to share knowledge between organizations within the framework of their activities in the RIS.



**Figure 5.** Potential of systemic functions to address the challenges of the Risaralda RIS. Source: Work team of the ‘Gestión del Sistema Regional de Ciencia, Tecnología e Innovación’ Project (2017).

## 5. Discussion: lessons for a governance framework of the Risaralda RIS

As the overarching research question we aim to address in this paper is *how can the governance of RIS be conceived from a functional perspective?*, in this section we focus on the sub question of *what can be learned from the case of the Risaralda RIS*, deriving lessons from the operational questions formulated in the methodology.

First, regarding *the characteristics, strengths and weaknesses (systemic failures) of the Risaralda RIS*, it became evident as a result of the exercises done that the definition of a governance framework for the Risaralda RIS that accounts for its functions, structure, and specific features would only make sense if it relies on the participation of local stakeholders, since they are the ones that know the systemic failures of the RIS better, as well as the functions and instruments that should be implemented to correct them. In fact, as presented before, the analysis of the case of Risaralda shows the existing systemic failures that, apart from the structural ones (lack of resources, low institutional capacity, etc.), include a weak interaction between stakeholders because of the lack of trust and the low quality of interlinks. This finding is consistent with claims by Orozco (2004) and Woolthuis, Lankhuizen, and Gilsing (2005).

Results show that most of the stakeholders in the RIS develop entrepreneurial or scientific activities, so a better supporting structure is needed for them. In the same vein, the workshops showed that further development of the RIS must be based on a governance scheme, independent and autonomous from political-electoral processes in the short term, and led by legitimate organizations (e.g. Regional Competitiveness Commission). In this regard, and as stated by some of the participants in the workshops, some of the systemic failures in the RIS include the weakness of the supporting institutional arrangement for innovation given the discontinuity of previous efforts in a constantly changing political landscape. This

reinforces a common tension between RIS processes and political dynamics, as highlighted by Llisterri, Pietrobelli, and Larsson (2011) regarding other RIS in Latin America.

Likewise, concerning the second question of *how and to what extent the Risaralda RIS is functionally integrated*, it became evident that there is a need for more stable interaction and coordination channels for relevant stakeholders in the system. Furthermore, the case studied suggests a central role of universities which have the potential to intermediate and facilitate interactions in IS, as stressed also by Cummings (2016) and Vilela et al. (2016) with respect to other RIS in emerging economies.

Two main patterns of interactions were identified in the network: (a) some stakeholders sustain multiple but weak interactions, while others (b) have very few but stronger relationships. These two patterns are rather complementary more than being mutually exclusive or simply good or bad. In other words, if there are many interactions with low productivity, more targeted strategies should be implemented in specific processes with higher potential. In contrast, if a stakeholder has few interactions it is necessary to look for new ways to facilitate the development of new alliances to boost its performance both individually and collectively. This finding is consistent with the governance challenges stressed by Smits and Kuhlmann (2004) and the potential balancing role that can be attributed to systemic-types of innovation policies; and with Jessop (2003), who highlights the role of meta-governance frameworks able to facilitate policies that 'collibrate' among tensions.

Third, regarding *how the Risaralda RIS contributes to developing, diffusing and using innovations by means of systemic functions*, an interesting finding is the contrast between what stakeholders perceive as functions with some degree of presence in the RIS and those that need to be strengthened for a better performance of the system. In fact, as Bergek et al. (2008) posit, the existence of a function in a system does not necessarily guarantee the 'goodness' of it. In this regard, stakeholders highlighted the need to enhance those functions that they perceived as having the highest presence in the RIS, such as the promotion of entrepreneurial culture and the development of knowledge.

Moreover, the perception of stakeholders of a low presence of certain functions contrasts with their higher perception of the extent to which they contribute to the development of the same functions, which raises two possible interpretations. First, this contrast shows the limitations for stakeholders to acknowledge the work of others given the disperse character of the network: a network in which the contributions of other local stakeholders to some functions are overlooked and therefore make it difficult to build stronger collaborations. Second, it is possible that the potential for the development of certain functions is not being fully grasped because of the weak integration of stakeholders in the network of the Risaralda RIS. In this regard, more integration of stakeholders would imply more contributions of this regional network in articulating knowledge development with multi-sectoral local needs. This finding is consistent with Tomassini Urti, Bianchi, and Couto Soares (2019)'s findings, who studied the Brazilian case.

Finally, functions such as counteracting resistance to change and the creation of new markets for innovation do not stand out in any subsystem, nor are they perceived to be developed enough in the RIS, suggesting a lower importance of these functions compared to the others. Particularly, counteracting resistance to change is also perceived to be further strengthened but to a lower degree, suggesting some degree of legitimacy of innovation as a mechanism for territorial development. We must also highlight that

stakeholders acknowledge the existence of resources for innovation in the RIS, but they point out that these are not being efficiently used and are allocated mostly based on political rather than efficiency criteria. This is related to the prevalence of financial instruments for innovation, so more and better systemic instruments are needed, as extensively argued in mainstream literature (e.g. Smits and Kuhlmann 2004).

The discussion presented so far shows a perception of the relative importance of systemic functions, implying the existence of a function ‘hierarchy’ within the Risaralda RIS, according to its specific features and context, as well as the particular institutions and stakeholders that operate in it. In fact, according to each territorial or sectoral context, some functions might have an influence over others (Hekkert et al. 2007). The existence of prioritized and enabling functions requires further research, possibly leading towards a typology of RIS based on the prevalence of certain systemic functions.

## **6. Conclusion: a proposal for a governance framework of the Risaralda RIS**

In view of the foregoing, we shall discuss a systemic governance framework from a functional perspective. This proposal responds to the question of *how the governance of RIS can be conceived from a functional perspective*. To answer to this conceptual question grounded on a *real-life* case study, we looked at the main features of Risaralda’s RIS, to assess its applicability and the challenges characterizing such endeavour. To do this, we envisioned (i) a set of derived strategic objectives and systemic instruments to be implemented, and (ii) an operational institutional arrangement necessary to support the implementation of these instruments.

### **6.1. Systemic instruments to boost the Risaralda RIS**

Following the theoretical framework discussed, the prioritized systemic functions were collectively translated into strategic objectives, defining strategic actions and instruments to achieve them through systemic instruments for the Risaralda RIS. Table 3 summarizes this process.

The implementation of these strategies with an appropriate systemic governance for the RIS implies, as suggested in the literature review, to maintain dynamic and active spaces for citizens concertation/participation. This includes dialogue processes that go beyond ‘informing’ the public concerning decisions that have been made and, instead, to include stakeholders in the decision-making process in order to harness their knowledge and experience. The analysis shows that there are relatively few stakeholders in the interface subsystem (intermediaries), where most stakeholders perceive that it is necessary to strengthen the diffusion of knowledge and information within the RIS. This needs to be supported by formally institutionalized analysis, monitoring and evaluation schemes for the RIS, as well as a more fluent interactions between stakeholders. In this regard, a proposal is presented upon continuation.

### **6.2. Governance structure for the Risaralda RIS**

Here we present a functional and multilevel governance framework to support the achievement of the derived objectives and strategies formulated above. This framework

**Table 3.** Derived action plan for the Risaralda RIS.

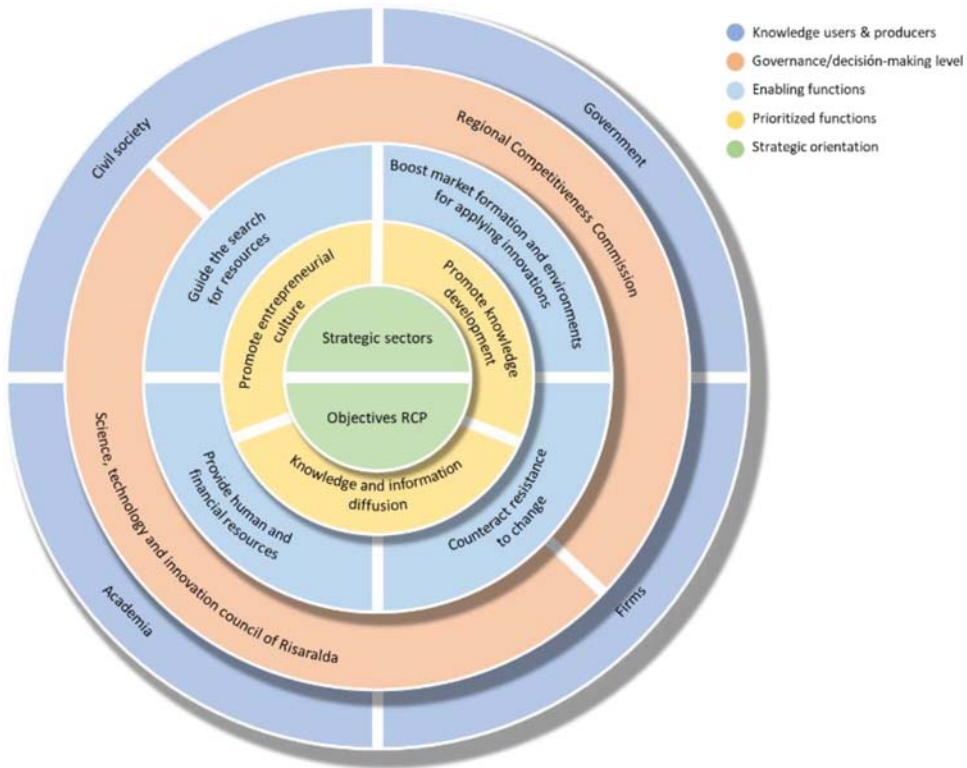
Strategic objectives	Specific actions and instruments
Promote entrepreneurial culture to create enabling environments for people to have the capacity of acknowledging and harnessing new knowledge, networks and markets that provide opportunities for business or for the design of new solutions to problems	<ul style="list-style-type: none"> <li>• Appropriation of validation tools by stakeholders that develop entrepreneurial promotion activities</li> <li>• Promotion of the use of strategic intelligence tools and technological vigilance by academic, entrepreneurial and governmental stakeholders at the state and municipality levels</li> <li>• Definition of a strategy for the promotion of entrepreneurship in higher education institutions, by strengthening the Entrepreneurship Table of the Network of Universities of Risaralda</li> <li>• Reviewing curriculums at universities in order to promote the economic harnessing of knowledge and social inclusion</li> <li>• Conducting diffusion campaigns for innovation</li> </ul>
Promote the development of knowledge that contributes to learning and its absorption, in order to develop experimental R&D, allowing individuals to learn by doing	<ul style="list-style-type: none"> <li>• Update the contents of curriculums at universities to make them more relevant for territorial needs and potentials</li> <li>• Promote research with impact and the regional and local levels</li> <li>• Implement incentives for acknowledging the work of firms that collaborate in research projects with universities</li> <li>• Promote initiatives for enabling access to territorial infrastructure (public labs)</li> <li>• Characterizing stakeholders to initiate collaboration processes based on local needs</li> </ul>
Facilitate knowledge and information diffusion between stakeholders, as well as learning by using knowledge and by interacting	<ul style="list-style-type: none"> <li>• Defining strategies for collecting, processing and diffusing information</li> <li>• Provide consultancy services on requests, needs, processes, protocols, access to information and local problem solving of innovative stakeholders</li> <li>• Systematizing scientific and technological local infrastructure to better respond to social needs</li> </ul>
Integrate monitoring, evaluation and analysis processes to the RIS, with indicators and metrics to provide feedback to the strategies of the RIS	<ul style="list-style-type: none"> <li>• Develop a proposal for local governance indicators to measure the performance of the strategies in the RIS, and to provide feedback of them to enhance their operation</li> </ul>

Source: Work team of the 'Gestión del Sistema Regional de Ciencia, Tecnología e Innovación' Project (2017).

is comprised of (i) an organizational-central level, including the legal framework of the science, technology and innovation council of Risaralda; (b) a tactical level, with a series of technical tables led by the Regional Competitiveness Commission; and (c) an operative level, with the systemic functions developed in the RIS (Figure 6).

This framework shows how the prioritized functions are articulated, along with enabling functions and departing from a strategic orientation, with knowledge producers and users represented by CODECTI and CRC. The framework integrates both vertical and horizontal coordination approaches (Chaminade and Padilla-Pérez 2017), as illustrated in (i) the objectives in the Regional Competitiveness Plan (RCP) which are developed in each sector (horizontal); and (ii) nine strategic sectors prioritized in Risaralda (vertical). These two components represent the strategic orientation level (green) in this governance framework of the Risaralda RIS (Figure 6).

Figure 6 shows prioritized systemic functions in a second level (yellow), whose implementation would take place in the short term. The viability of these functions depends partially on the enabling functions at the third governance level (light blue),



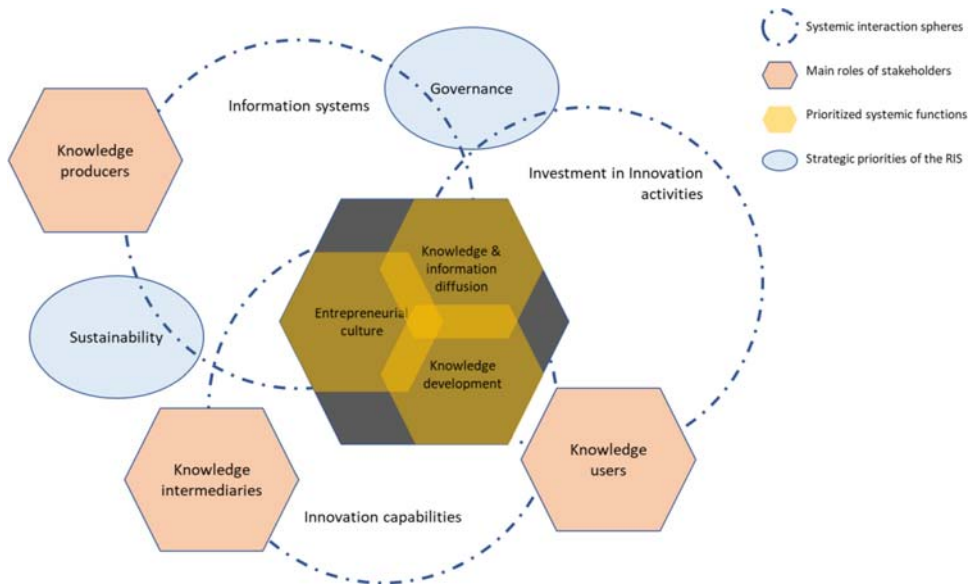
**Figure 6.** Systemic and multilevel functional governance framework for the Risaralda RIS. Source: Work team of the ‘Gestión del Sistema Regional de Ciencia, Tecnología e Innovación’ Project (2017).

which would be implemented in the long term since they require a deeper cultural transformation in the RIS and therefore, have a more complex governance. Finally, the decision-making governance level is comprised of a science, technology and innovation council of Risaralda and the Regional Competitiveness Commission (orange), which are bodies that seek to assure the organizational efficiency of the system; and the final broader level includes producers and users of knowledge (blue), which are the main beneficiaries of the activities of the system (academia, civil society, government, firms).

Furthermore, we propose the following operational-conceptual model for the previous functional governance structure to operate properly (Figure 7). This model highlights the role that producers, intermediaries and users of knowledge play in certain systemic interaction spheres related to information systems, investment in innovation activities, and capacity building, in order to support the prioritized systemic functions. With this, it would be more feasible to achieve the strategic objectives of the system regarding sustainability and governance.

In this model, the RIS is conceived as a flexible set of institutions and organizations with multiple adaptative instances, which requires few resources at the beginning. More empowerment and participation from stakeholders is needed for the operation of the RIS, leading to a stronger legitimacy of the framework and more resource mobilization to support it.





**Figure 7.** Operational-conceptual functional governance model for the Risaralda RIS. Source: Work team of the ‘Gestión del Sistema Regional de Ciencia, Tecnología e Innovación’ Project (2017).

In sum, an effective systemic governance for innovation at the regional level requires new institutional arrangements and arenas to foster dialogue, interactions and collective decision-making between stakeholders with the purpose of addressing systemic failures in a more efficient way, as well as for boosting key supporting systemic functions in RIS in emerging economies (Costamagna and Larrea 2017).

### 6.3. Final remarks

In this paper, we have addressed the question of *how the governance of RIS can be conceived from a functional perspective* by analysing the case of Risaralda (Colombia) in 2017. In order to respond to this question, we define the governance of RIS from a functional perspective as a process in which innovation practice, theory and policy coevolve in a permanent learning process (Kuhlmann, Shapira, and Smits 2010; Kuhlmann and Ordóñez-Matamoros 2017). This process enables interaction between multiple stakeholders of the system in debate arenas and instances in order to produce binding decisions for implementing systemic instruments, correcting systemic failures and boosting systemic functions (Kuhlmann, Shapira, and Smits 2010).

In this context, we looked at what the most important systemic functions are according to the perception of local stakeholders, and proposed an operational and conceptual governance framework for the implementation of strategies that strengthen these prioritized and enabling functions. We find that the Risaralda RIS has a remarkable innovation performance compared to other states in Colombia, but several systemic failures remain regarding the quality of institutions for innovation governance and the lack of interactions between stakeholders, not only within the State but also with stakeholders in neighboring States in the country.

Overall, the functional approach to RIS is proved useful as a means of approaching the innovation governance dynamics that take place in the Risaralda State. Even though the question regarding the normative biases of this approach remains when analysing cases in Latin America (Llisterri, Pietrobelli, and Larsson 2011), it allows us to build bridges between systemic and functional analysis of innovation integrating specific regional processes and enabling a better understanding of the complexities of the region under study. In the case of Risaralda, as shown, stakeholders identified the systemic failures and functions proposed by literature on the topic, which represents a guiding framework to define territorial priorities. However, results suggest a possible ‘hierarchy’ in systemic functions in this case, according to the prioritization made by stakeholders for the specific territorial context of the Risaralda RIS where, depending on the specific contexts, some functions seem more relevant than others. A possible future line of research can be developed here, inquiring into what types of RIS could be identified according to the prevalence of certain functions.

Further research is required on how the specificities of Latin American political processes and systems might affect the governance of innovation at the subnational level, as well as the innovation performance of different regions. Particularly, some topics for further inquiry are the impact of political-administrative boundaries on regional and innovation processes when the latter go beyond such limits as the case in question, as well as the extent to which these boundaries operate as barriers for or enablers of innovations practice and governance.

Other open questions remain from the findings of this study if governance challenges are to be addressed and frameworks are to be envisioned in other emerging economies’ contexts. These include (a) the role of ‘(dis)trust’ and low quality of interactions among actors (Orozco 2004; Woolthuis, Lankhuizen, and Gilsing 2005), (b) the role of politico-institutional (in)stability (Llisterri, Pietrobelli, and Larsson 2011), (c) the mediating role of regional universities (Cummings 2016; Vilela et al. 2016), (d) the overarching governance challenges and the potential roles systemic policy tools and of tensions’ collibrators (Smits and Kuhlmann 2004; Jessop 2003), (e) a systems’ function’s hierarchy (Bergek et al. 2008), and of course f) the role of regional networks in articulating knowledge development.

The case study of Risaralda conducted here adds to the growing body of literature that analyses RIS dynamics in Colombia, as has been done for the case of Bogotá, D.C. (Calderón et al. 2016), Atlántico (Ortiz 2012), Valle del Cauca (Caicedo 2012), Santander (Arias et al. 2013), or Antioquia (Jiménez, Fernández de Lucio, and Menéndez 2011; Cote-Peña et al. 2016). Moreover, this is a contribution to the analysis of RIS for strengthening systemic governance in Colombia, which is in turn a topic that needs further development from more functional and less structural approaches that contribute to a better understanding of RIS dynamics in the Global South (Szogs, Cummings, and Chaminade 2011; Andersen 2015). The expected results of such studies are to improve STI evidence-based policymaking in Colombia, for it to be more relevant and attuned to the local potential and needs (Ordonez-Matamoros et al. 2013; Ordonez-Matamoros et al. 2018; Centeno and Ordonez-Matamoros 2019; Pinzón-Camargo, Ordoñez-Matamoros, and Kuhlmann 2020).

## Notes

1. United Nations Economic Commission for Latin America and the Caribbean.

2. Inter-American Development Bank.
3. Exceptions can be found in the work of RedeSist in Brazil (Matos et al. 2017) or in the work of Cummings (2007) regarding the case of El Salvador. Additionally, a detailed reflection of the tensions and limitations for the operationalizations of the RIS concept can be found in Navarro (2009).
4. We do not assume the appropriateness of the systemic approach as a ‘recipe’ for innovation governance. On the contrary, we adopt it as a conceptual approach for a better understanding of territorial innovation dynamics. In any case, we suggest the work of Navarro (2009) for an examination of the usefulness of the systemic approach for analytical and policy purposes.
5. Here we understand institutions from the point of view of Douglass North as formal or informal ‘rules of the game’ that regulate interactions between stakeholders.
6. It is worth clarifying that, as suggested by one of the reviewers of this paper, ‘the concept of institutionalization in Latin America is a combination of organizations and institutions, usually public, that one way or another structure or configure systems’.
7. Given the word limit of the paper, we suggest referring to further methodological details of social network analysis in Wasserman and Faust (2013).
8. With three branches of the Andean mountain range that crisscross the country, coasts both on the Pacific and Atlantic oceans, and large tropical rain forests in the Amazon and the Pacific regions.
9. See *Índice Departamental de Competitividad* 2019: <https://compite.com.co/indice-departamental-de-competitividad/>.
10. See *Índice Departamental de Innovación de Colombia* 2019: <https://colaboracion.dnp.gov.co/CDT/Prensa/Indice-Departamental-Innovacion-Colombia-2019.pdf>.
11. See *PECTI de Risaralda*. In: <https://minciencias.gov.co/portafolio/gestion-territorial/planes-de-acuerdo/planes-acuerdos-estrategicos>.

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## Appendices

### Appendix 1. Stakeholders in the Risaralda RIS

Stakeholder	Degree	Stakeholder	Degree	Stakeholder	Degree	Stakeholder	Degree
Universidad Tecnológica De Pereira	140	Ingeniar Inoxidables	19	Instituto Del Sistema Nervioso	7	Alcaldía De Manizales	3
Gobernación De Risaralda	128	Min. Industria, Comercio Y Turismo	18	Alcaldía Balboa	7	Artesanías De Colombia	3
CC. Pereira	121	ACOPI	18	Camicol Dotaciones	7	Normarh	3
CC. Dosquebradas	92	CEMAB	17	Consejo Privado De Competitividad	6	Metgroup	3
U Andina	88	Alcaldía De Dosquebradas	15	U. Cooperativa	6	Frigorífico Del Otun	3
SENA	86	CO&TEX	15	Reencafé S.A	6	GL Ingenieros	3
Universidad Católica De Pereira	84	Federación Nacional De Cafeteros	14	Cenicafe	6	U. NORTE	3
Cindetemm	68	MAGNETRÓN	13	CIDCA	5	Coats Cadena Andime S.A	3
CIDT	64	Federación Clúster TIC Del Triangulo Del Café	13	UNALMED	5	U. De De Los ANDES	3
Alcaldía De Pereira	63	PROCOLOMBIA	12	Tanque TIC	5	Neurocity	3
Universidad Libre	57	Novitas	12	DANE	5	CHEC	3
Incubar EC	55	Proyectnova S.A.S	12	Planeación Nacional	5	AUNAP	3
Colciencias	50	SGR	11	SITE	5	Gobernación De Caldas	3
Parque Soft	50	AMCO	11	U. Javeriana	5	Café Y Compañía S.A	3
Tecno Parque	38	Instituto De Epilepsia Y Parkinson - Neurocentro	11	Consultora IXL Center	5	Alimentos Del Valle S.A	3
La Mas Emprendedora	37	UNAL(Manizales)	11	SECAD-FAC	5	Comercializado Agua Y Pureza	3
Entreverdes	36	CORPOICA	11	Red Metalmecánica	5	ASCAM-Eurecat	3
UNISARC	34	U Del Quindío	10	Clúster Aeronáutico CLAR	5	Comité Intergremial	3
Ingenio Risaralda	33	ARL SURA	10	CONFAMILIAR	5	CORA	3
Comisión R. Competitividad	31	Clesus S.A.S	10	ICBF	5	Mercados Agroecológicos	3
Innpulsa	30	Sociedad En Movimiento	10	ORMET	5	Agencia Colombiana Para La Reintegración	3
U. EAFIT	29	Min. Agricultura	9	Red Ilumno	5	Aerorental	2
Frisby	29	BID	9	YMCA-ACJ Fundación	5	Colegio Ma. Dolorosa	2
ANDI	28	CIAF	9	Enfacences Fundación	5	Colegio El Retiro	2
Todos Por La Tolerancia	28	CC. Manizales	9	Metrycos Y Controles	4	Colegio Mundo Nuevo	2
Integra S.A	26	Tecno Academia	9	Universidad De Las Américas	4	ICONTEC	2
Zion ING S.A.S	24	Comité Departamental De Cafeteros De Risaralda	8	La Voz De La Consciencia	4	Inexmoda	2
CC. Sta Rosa	24	Confecámaras	8	American Bussinesses	4	AIIESEC	2

(Continued)

**Appendix 1. Continued.**

Stakeholder	Degree	Stakeholder	Degree	Stakeholder	Degree	Stakeholder	Degree
Fundación Sembrar Futuro	24	Sayonara	8	ICA	4	Empresarios Por La Educación	2
Bancoldex	24	Fundación Frisby	8	UNAD	4	Pereira Como Vamos	2
CARDER	22	Min. Transporte	8	Red Departamental De Emprendimiento	4	Alcaldía De Sta. Rosa	2
Empresa De Energía De Pereira S.A	22	Cenicaña	8	FENALCO	4	U. SABANA	1
Grupo GEMAS S.A.S	21	PEKY S.A.S	8	Metalgas S.A	3	Mesa Departamental De Jóvenes	1
BUSSCAR	20	Aguas Y Aguas	7	INPE	3	Futuros Dirigentes	1
Red De Nodos	19	Homeris	7	Colegio Ormaza	3		

Source: Work team of the 'Gestión del Sistema Regional de Ciencia, Tecnología e Innovación' Project (2017).

**Appendix 2. General features of the workshops held in 2017**

No.	General objective	Guiding questions	No. of participants
Workshop No. 1	To collectively identify the main challenges, strategies and possible agreements in stakeholders of the RIS	What are the main challenges (needs and non harnessed opportunities) that limit the consolidation, efficiency and sustainability of the Risaralda RIS? What are the main strategies that the Risaralda RIS should implement in order to contribute to the solution of the previously identified challenges?	45
Workshop No. 2	To present and provide feedback to the inputs of organization and operation regarding the design of the governance model for the Risaralda RIS	What guidelines are needed for the operation of the Risaralda RIS? Would you change or complement the previously presented guidelines? What changes or recommendations would you propose to optimize the operation of the RIS? What are your concrete proposals to boost the systemic functions of the Risaralda RIS?	80
Workshop No. 3	To present the governance scheme designed for the Risaralda RIS	What strategies are currently developing in Risaralda to enable the operation of functions? What is the criteria to prioritize the needs to be addressed in the RIS?	40
Workshop No. 4	To propose in a collaborative and collective way the needed central elements to boost the Risaralda RIS	Why do we want an operational RIS? What is it useful for? What guidelines should be implemented at the strategic, operative and tactic levels regarding the functions of the RIS? How should the RIS be led? How can we contribute to the RIS becoming sustainable over time?	8
Workshop No. 5	To present the results of innovation measurements and to discuss them in regards to what each stakeholder has been doing in order to contribute to strengthening the Risaralda RIS	What is needed in the entrepreneurial sector to sophisticate the use of knowledge and technology? On what elements should local governments focus in order to enhance the performance of the RIS? What indicators inform on the current capacities, inputs and features in each RIS subsystem? How are inputs reflected on result indicators according to innovation	37

(Continued)



**Appendix 2.** Continued.

No.	General objective	Guiding questions	No. of participants
		measurements? How can academia contribute to a productive and more sophisticated environment?	
Workshop No. 6	To present the results of the design of the RIS governance framework to the Regional Competitiveness Commission, for its feedback and approval.	Does not apply.	56

Source: Work team of the 'Gestión del Sistema Regional de Ciencia, Tecnología e Innovación' Project (2017).