Martha Lucia Agredo Díaz [1]

Frank Alexander Ramírez Ordoñez

Raúl Andrés Tabarquino Muñoz

OPEN INNOVATION AND PUBLIC POLICIES IN DEVELOPING COUNTRIES

Abstract: This article attempts to extend the debate on open innovation and public policies in developing countries. It presents the case of the public policy of Competitiveness, Science, Technology and Innovation CSTI in the department of Valle del Cauca, Colombia, analyzing the dynamics and network structure of the open innovation actors in the policy according to breadth and depth relations using a network methodology. The results showed that the relationship between the actors needs to be expanded from breadth to a depth relation. Consequently, the policy´s network in the region holds important implications for the management of open innovation and public policies where heterogeneous actors interact.

Keywords: Open Innovation; Public Policies; Networks

1. Introduction

The economy must adapt to the new dynamics of the modern world. Growth and sustainable development are only possible if changes in society are achieved from innovation that has been defined from different perspectives in a context of globalization that arouses great uncertainty (Pollitt & Hupe, 2011). One perspective is open innovation. Open innovation initially emerges with Chesbrough's approach in the early 2000s, as a purely business concept that has recently been redefined for a broader application to other types of organizations and even with opportunities in public policies. According to Chesbrough & Bogers (2014), open innovation describes a distributed innovation process that relies on knowledge flows managed intentionally across the boundaries of organizations to improve their innovation success. While the

original concept is firm focused, open innovation has become relevant in public policies context where the relations between different actors and the flow of knowledge between them help to respond to different problems or needs in society (Chesbrough & Bogers, 2014; Bogers et al., 2017). As Borges et al (2017) points out, developments from this context are still scarce.

Both in academic research and in the domain of public policies, this concept has become increasingly relevant given the complexity and dynamism implicit in innovation processes. According to Borges et al (2017), open innovation can be studied at different levels such as: intra-organizational level, that is, within the organization in functional areas or business units; organizational level, that is, at the level of the organization in its business model; extra-organizational level, that is, at the level of communities or organizations; inter-organizational level, that is, at the level

---

[1] Corresponding author: Martha Lucia Agredo Díaz
  Email: martha.agredo@correounivalle.edu.co

of alliances, networks or ecosystems; and finally at the industrial, regional or innovation systems and society level. Analyzing open innovation on different levels of analysis can enrich our understanding of open innovation (Chesbrough et al., 2006).

The needs of citizens and technology advances suggest an immense need for innovation in the public sector since citizens have higher expectations about government interventions. Likewise, public administrators and elected politicians have increasing ambitions regarding the improvement of public governance mechanisms and stricter control (Gascó, 2017). In this sense, public tasks have become increasingly complex with problems that are often too difficult to solve by a single entity and therefore require the participation of other actors (Sørensen & Torfing, 2011). Recently government organizations had begun to adopt open innovation approaches as an additional gateway for the creation of innovation that allow citizens to suggest solutions to public management problems (Mergel & Desouza, 2013). Although the specific way in which open innovation can become a tool for governments remains as a little explored topic with many concerns (Feller et al., 2011).

The most investigated literature has been focused on external knowledge search of the firm at organizational level where the implementation of open innovation models had leads both to the success of innovation and to the improvement of business performance (Laursen & Salter, 2006; Leiponen & Helfat, 2010; Garcia Martinez et al., 2014). Across studies, research has been limited in explaining the open innovation from an inter-organizational perspective.

First, where organizations actively participate in ecosystems with diverse actors in order to explore and develop new innovation policies and instruments to solve problems in the society (De Jong, et al., 2008; Bogers et al., 2017). Second, where the interaction between multiple actors allows create useful solutions (Iansiti & Levien, 2002). Finally, related to the theory of networks, where public policies emerge from the interaction of different actors (Marsh & Smith, 2000).

Searching studies using the ISI Web of Science Database evidence that the principal countries with studies on open innovation are mostly developed countries, por example United States, England, Germany, Spain, Italy, Netherlands, France, Canada and Australia. Studies in developing countries are less frequent (Lopes & de Carvalho, 2018). In this sense, the purpose of this article is analyzing the dynamics and network structure of the open innovation actors in the public policy of Competitiveness, Science, Technology and Innovation CSTI in the department of Valle del Cauca in Colombia. An analysis according to breadth and depth relations at the inter-organizational level, attempting to extend the debate on open innovation and public policies in developing countries contexts and considering that this policy was formulated in a participative way with different actors.

This article[2] contributes to research in public policies where the role of governments and interactions between heterogeneous actors in a world of open innovation is still uncharted (De Jong et al., 2008; Bogers et al., 2017). Additionally, this article helps to expand the analysis of public policies based on open innovation.

From the network analysis, in this work it has been tried to approach one of the main problems that the Colombian economy has had to face over several decades, consisting of low levels of competitiveness and development linked to low levels of innovation. Innovation that should not be simply understood as a business innovation or as a responsibility of the government, but as a collaborative and shared innovation that is called open innovation among the different actors of an ecosystem that includes the government, the business sector, organizations of higher education and nonprofit organizations.

This paper is structured as follows. First, it draws on the open innovation and open innovation and public policy networks theory literatures to discuss the different levels of analysis in the open innovation research. Second, the methodological approach to study the public policy of Competitiveness, Science, Technology and Innovation (CSTI) in the Valle del Cauca and its most relevant open innovation actors. Third, it presents the analysis and results in terms of the network dynamics and structure of the public policy. Finally, it presents the conclusions.

2. Theorical background

One of the great challenges posed by today's societies is related to the ability to develop new ways to work together with the objective of solving highly complex public problems such as low levels of innovation to improve competitiveness in a country or region. These types of transformations require new ways and instruments of approach, leaving aside classical dichotomous approaches such as state vs. market vs. society. As Daniel Coyle (2018) points out, to build more than the simple sum of the parts it is necessary to build safety, share vulnerability and stablish purposes, which in turn relates to one really important element that is trust. In this sense, the need to innovate is based on new interaction logics such as open innovation

where build common purposes and trust is essential.

According to the literature, the term open innovation was first coined by Henry Chesbrough from a purely business perspective in 2003, defining open innovation as the set of valuable ideas that can come or go to the market both from the inside as the outside of the company through different actors, being at the same level of importance both external and internal ideas. The theory points out that the open innovation model focuses on the creation of value from the use of internal and external sources to the organization, which involves a significant growth in the number of actors, that contribute to innovation (Chesbrough, 2003).

Emphasizing the idea of knowledge flows inside and outside the company, Chesbrough et al. (2006) redefined the concept of open innovation as the use of knowledge entry and exit flows in order to accelerate the internal innovation of companies and expand markets to take advantage of innovation for external use. Based on this definition, the concept of open innovation is related on the one hand in the development of innovation in companies at the internal level with the use of external sources and, on the other hand, the external use of innovations developed within the company to go them to the market (Lopes & de Carvalho, 2018).

In order to broaden the concept of open innovation to encompass a large number of organizations, not just business organizations, Chesbrough & Bogers (2014) describe open innovation as a distributed innovation process that is based on knowledge flows managed in a intentional way across the boundaries of organizations to improve their innovation success. Although this definition, emphasizes in its essence the company as focus of analysis, it starts a slightly broader conceptualization that allows visualizing innovation as a distributed process that can be taken to different levels of analysis. Borges et al. (2017) define these levels of analysis in five types that are: intra-organizational level;

organizational level; extra-organizational level; inter-organizational level and industry level, regional innovation systems and society.

From the inter-organizational perspective, the effectiveness of open innovation depends not only on knowledge flows between organizations in the initial stages of innovation processes, but also requires that organizations organize themselves and actively participate in ecosystems of innovation that integrate a wide variety of actors (Borges, et al 2017). In this type of perspective, the actors in the process collectively create useful and innovative solutions for problems of mutual interest, with the participation or not of a central organization as the cornerstone of the process (Iansiti & Levien, 2002; Borges et al, 2017).

According to Dhanaraj and Parkhe (2006), taking the theory of networks as a lens, open innovation allows to describe network structures that emerge from interactions of a diverse set of actors throughout the innovation process.

Analyzing open innovation from the theory of networks allows broadening the scope and enriching the knowledge about this concept that in the inter-organizational level allows to understand the relationships between organizations or actors that make up innovation ecosystems and innovation public policies. These relations in turn allow other higher levels of open innovation to be strengthened, such as regional innovation systems and the national innovation systems as indicated in Figure 1 (Chesbrough et al., 2006; Bogers et al., 2017).

- Intra-organizational level
- Organizational level
- **Inter-organizational level**
- Regional Innovation System
- National Innovation System
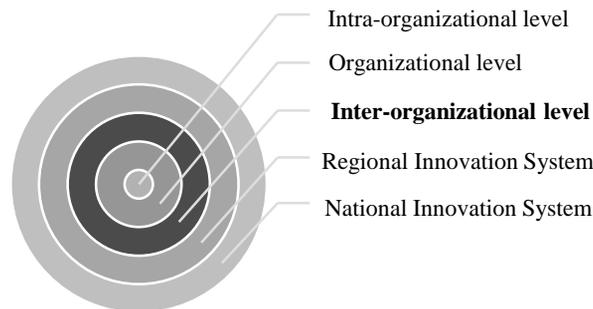
Figure 1. Levels of analysis for open innovation. Based on Borges et al., (2017).

Open innovation has a tremendous impact at the business level, however this definition has transcended and led to the inclusion of multiple actors because sustainable innovation on the time must be for everyone (Chesbrough & Bogers, 2017). In this way open innovation is related to public policies and it could be analyzed from the network approach where public policies emerge from the interaction of different actors classified at an inter-organizational level (Marsh & Smith, 2000). A concept that was initially adopted in the business sector, over the last few years has also begun to become relevant in public administration (De Jong, et al., 2008; Bogers et al., 2017), as an instrument to frame the

transformation of public sector organizations in order to improve the effectiveness, efficiency and legitimacy of their public value creation processes (Gascó, 2017).

These considerations are based on how various approaches to open innovation, both from the business field and from the government and its dynamics inside and outside organizations, emphasize the interaction of actors as a key element to lead to success in innovation processes even when the nature of such actors differ in some aspects as focus, objectives and added value (Mergel & Desouza, 2013). As outlined above, even if the actors are from a different nature, they can belong to an ecosystem, and

as a whole they can work towards common interests that can be achieved as a result of proper articulation (Etzkowitz & Leydesdorff, 2000).

2.1. Open innovation and public policies

Open innovation is a concept that has become increasingly popular among professionals and academics, but its implications for the formulation of public policies it has not been analyzed in detail (De Jong et al., 2008). Based on a theoretical framework that structures the debate on policies that promote open innovation, it could be conclude that open innovation approach deserves attention in innovation policies and in a wide range of areas, overcoming limitations for the development of capacities of innovation (Silva et al., 2008).

The typical closed innovation model that is developed and disseminated only within the company, has become obsolete and does not contribute to improving the levels of competitiveness in the countries (De Jong et al., 2008). Currently, given the increase in the mobility of factors, increased education, increasing presence of risk capitals, short life cycle of products, increased competition and wide availability of knowledge from multiple sources, public policies should be aligned with the behavior of innovative companies and external conditions should motivate all organizations to open innovation. This could generate positive externalities with returns not only of business but also social, by allowing a better dissemination of knowledge. The evidence on the positive social externalities of open innovation provides a justification for public policies to promote open innovation practices among companies (Roper et al., 2013).

Chesbrough & Vanhaverbeke (2018) support the idea that public policies should be guided from an open innovation approach. Motivated by the success stories of the open innovation paradigm in the private sector, and also by the increasing complexity of social problems and needs, different countries in the public sector have begun to move in this direction, trying exploit the broad knowledge of citizens for the development of innovations in public policies and services (Loukis et al., 2017). Some examples have been the petition portal called e-people in the Republic of Korea, the case of open government in Germany as a platform for collaborating ideas (Kube et al., 2015) and the initiative of open government in the United States in the government of President Obama through the challenge.gov platform (Mergel & Desouza, 2013).

Cadiou and Chené (2017) highlight the importance of consider new forms of organization related to open innovation, forms of organization that really allow establishing a link between companies and universities to carry out innovation processes. Felin and Zenger (2014) carry out a study where they address different types of open innovation and conclude that as innovation problems become more complex, organizations should adopt practices that facilitate a broad exchange of external knowledge. The cities of the future have to be "intelligent" and in this sense, the open innovation model seems to provide efficient support for the participation of private companies in public partnerships, ensuring that there is efficiency and affordability in the provision of city new services (Ferraris et al., 2018). Thus, the current dynamics demand public policies that respond to the challenges and opportunities of knowledge networks and the processes of open innovation and interaction between multiple agents and ideas that are celebrated between them.

2.2. Open innovation and public policy networks

In a network approach, open innovation will be understood as the ability of different actors to work together to give new answers to problems or mutual needs (Borges et al., 2017) and where, as Traitler & Saguy (2009) points out, the basis is the confidence that leads to the improvement of well-being for the parties involved in response to the needs

of each actor. In open innovation it is important to clearly recognize the other, their goals and expectations in the process, and it is also important to establish relationships of trust and define the type of collaboration and the type of needs of the parties. Additionally, guaranteeing the legality in the processes and intellectual property rights so that agreements and contracts reached can be monitored and discussed with total confidence in order to generate solutions or rather innovations that lead to the improvement in the well-being or value creation that collectively generate improvements for society (Traitler & Saguy, 2009; Teja Gutiérrez et al., 2014) (Figure 2).
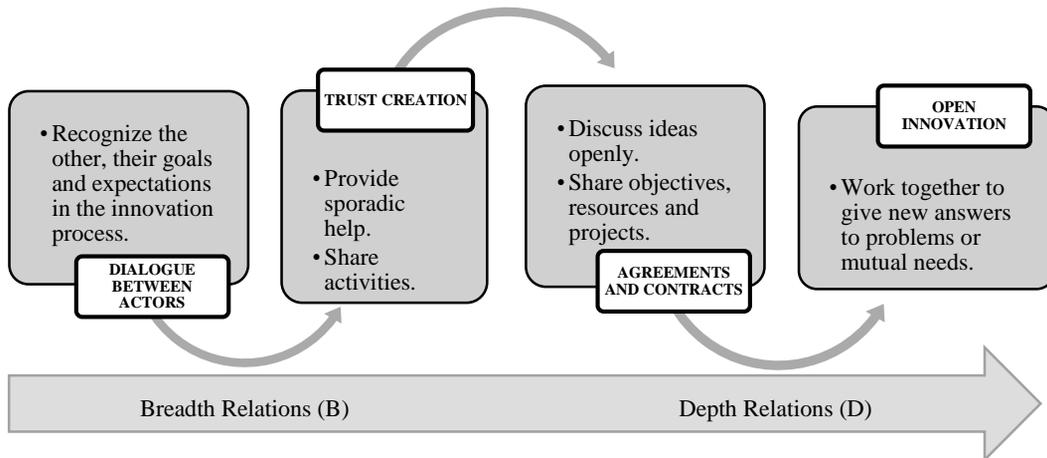

Figure 1. Innovations from open innovation. Adapted from Traitler & Saguy (2009) and Teja Gutiérrez et al., (2014)

Open innovation is the result of dialogue in which different actors are related to respond to mutual needs, being able to generate new ideas that redefine different solutions and ways to address problems. Policy networks are taken as conceptual tool to describe and infer what are the structures that allow determining the dynamics for a specific public policy, based on a dynamic game where different actors interact with their respective preferences (Muñoz, 2016).

Muñoz (2016) points out according to Professor Erik-Hans Klijn that one of the theoretical roots of policy networks is found in the political sciences where the focus of discussion is that political processes are complex interactions that involve many actors. Therefore, networks exist as a consequence of the interdependence relationships between different actors that have independent goals and where the relationships established are of a more or less lasting nature and are characterized by the existence of information flows (Martínez, 2001).

According to Martínez (2001) public policy network is a structure formed by more or less stable links that maintain a certain number of actors, public and private, exchanging, material and immaterial resources. That exchange is due to their mutual dependence on the process of formulation, decision and execution of public policies within a specific sector or sub-sector. Interdependence is a basic concept that sustains the need to maintain stable relationships between different actors in order to achieve specific political objectives, so that the set of actors ends up structuring a space where resources and information are exchanged, proposals are elaborated and discussed, transactions are negotiated and policies are defined (Muñoz, 2016) as has been the case with Public Policy of CSTI of Valle del Cauca.

3. Methodological approach

The research on open innovation has been initiated on case studies at the company level by Chesbrough (2003). Not surprisingly, there was an immediate demand for other units and methods of analysis (Bogers et al., 2017). This study uses an extensive literature review, documentary analysis, interviews with policy makers, consultation of policy review reports and other sources as notes and databases used in the formulation process of the Public Policy of CSTI. This paper also uses a network analysis to study the dynamics and network structure of the open innovation actors in the policy.

This paper entailed two stages. To identify the most relevant open innovation actors in the public policy it was carried out a systematization of the information collected based on the documents, notes, reports, an initial guideline of the actors implicated in the formulation of the policy. Next, various experts and innovation policymaking of the policy were interviewed to obtain feedback and comments about the relations and actors that participated in more active way in the formulation. Based on their feedback we mapped the principal actors in the process from higher education sector, business enterprise sector, government sector and non-profit sector, according to the Frascati manual[3].

When mapping open innovation actors, the first choice was what to include and what to exclude from the analysis. The focus of this study was the dynamics and network structure of the actors with mayor participation in the formulation of the Public Policy of CSTI. This includes different relations between actors. Based on the documents, notes and reports from the formulation of the policy it was possible identify 97 actors. Some actors include specific areas, worktables and committees made up of the same organizations. As these groups cannot be considered at the inter-organizational level, they have not been considered in the analysis. Consequently, the focus of this study was initially 85 actors.

Based on the interviews to policy makers and organizations and consultation of notes and databases used in the formulation process of the Public Policy it was possible identify that 33 actors actively participated in the formulation of the policy in different steps. 20 actors were considered to the analysis because chambers of commerce, clusters and associations were excluded because include various organizations no considered at the inter-organizational level of analysis. Table 1 shows those actors of open innovation who participated in the construction of the Public Policy of CSTI of Valle del Cauca, as representatives of each sector, on which the analysis of the dynamics and network structure was carried out.

In the government sector, Gobernación del Valle del Cauca was selected as the only actor because in this case the public policy is built and oriented by him who is also the leader of the innovation management system in the Valle del Cauca department.

In the second stage in a quantitative analysis the different actors were correlated with a symmetric matrix, that is a matrix where the actors are located both in the columns and in the rows to identify the relations between them based on the interviews to policy makers and organizations. The relations were classified based on Laursen and Salter (2006) and Garcia Martinez et al. (2014) who use two concepts breadth and depth, referring as two essential components of the level of openness of organizations' external search strategies.

---

[3] The Frascati manual is considered one of the most widely used guides for the collection and analysis of scientific, technological, innovation, research and development data - *Manual de Oslo. Guia para la recogida e interpretación de datos sobre innovación-*.

Table 1. Main actors of open innovation in the Public Policy of CSTI of Valle del Cauca

Business enterprise sector	Government sector	Higher education sector	Non-profit sector
Agromarina Tumaco S.A. Banco de Occidente Carvajal S.A. Coomeva Harinera del Valle Nutresa Sucroal S.A. Transportes Mejía S.A. Zona América	Gobernación del Valle del Cauca	Sena Universidad Autónoma de Occidente Universidad del Valle Universidad ICESI Universidad Javeriana Universidad Libre Universidad San Buenaventura Universidad Santiago de Cali	BIOTEC CIDEIM

The level of breadth, it is measured by the external sources with which companies establish relationships or trust their innovative activities. This scale was operationalized as the relationship of one organization with other. Each organization obtains a score of 0 when no relationship exists and a score of 1 when the organization has a relationship with other. The level of depth, it is measured as the level of strength of the relationship established with other external organizations and allows determining in this sense which are the most important partners or relationships for the organization. A score of 0 was considered when two organizations do not have a deep relationship and a score of 1 when two organizations have a deep relationship of collaboration in different activities and even share goals and resources. The information was introduced in the UCINET network program in order to visualize and analyze the dynamics and network structure of the open innovation actors in the policy. For an overview of the breadth and depth matrix, refer to Appendix I and Appendix II.

4. Analysis and results

4.1. Structural analysis in the public policy of CSTI network

The network structure is defined based on the approaches of Laursen and Salter (2006) who develop breadth and depth concepts.

According to the results, the relations and interactions of the network in the public policy of CSTI in Valle del Cauca, are given in greater intensity by breadth relations (B), that is by the number of external sources with those organizations are related and in less intensity due to depth relations (D), that is the level of strength of the relationships. In the network of public policy of CSTI the Breadth relations are high, and the Depth relations are low in relation to the total number of possible relations in the network.

Of the total possible relationships in the network (380), the breadth relations are equivalent to 74% (281 relations) versus 26% (99 no relations) and the depth relations are equivalent to 25% (93 relations) versus 75% (287 no relations). Therefore, the most relevant and more connected dimension in the network are breadth relations and the dimension of least relevance and lest connection between the actors in the network are depth relations. It is clarified that the depth relations (D), comply with the two dimensions of relationship in the network (breadth and depth), because having a high level of strength in the relationship (D) necessarily implies that there is a breadth relation (B). In this sense, of the total relationships that have breadth (281 relations), 33% have depth (93 relations).

For the structural analysis of breadth and depth relations, the indicators show a horizontal trend network due to its centralization index of 25.15% and 47.95%

there is not a single central actor in the network. In the case of breadth relationships, the network has high connectivity between actors due to its density of 74% with an average of 14 connections in relation to a minimum of 1 and a maximum of 19 links in the network and with dispersion of 4.1 connections per actor. In the depth relations the network is of low connectivity between actors for its density of 25% with an average are 4.8 connections in relation to a minimum of 1 and a maximum of 13 links in the network and with a dispersion of 3.7 connections per actor (Table 2).

Table 2. Structural indicators in the public policy of CSTI network

	Breadth Relations (B)	**Depth Relations (D)**
Nodes or actors	20	20
Relations in the network	281 (74%)	93 (25%)
Mean of relations in the network	14	4.8
Minimum and maximum value	1 - 19	1 - 13
Standard deviation	4.1	3.7
Network Centralization	25.15%	47.95%
No relations in the network	99 (26%)	287 (75%)
Total possible relations in the network	380 (100%)	380 (100%)

4.2. Positional analysis in the public policy of CSTI network

The positional indicators of degree indicate that in the breadth relations network, the Gobernación del Valle del Cauca, as a government actor, is the actor with the greatest connectivity and representativeness in the network with 19 relationships and 100% affinity in connectivity and also is noted that the Universidad Icesi, Universidad del Valle and the Universidad Javeriana lead the levels of connectivity in relation to higher education organizations with 18 relations and 94.7% affinity in connectivity in the network. In the business sector, the role of Harinera del Valle stands out with 18 relations and 94.7% affinity-connectivity in the network. The betweenness degree shows that the bridge actor with 44,1 and 12% is also the Gobernación del Valle del Cauca, followed by other higher education organizations such as the Universidad del Valle in second place and the Universidad Icesi and Universidad Javeriana, which repeatedly accompanies the Government in different activities. There are also two business actors that have an impact and are Carvajal and Harinera del Valle. The degree of closeness shows that the closest actors with the rest of the network are the Gobernación del Valle del Cauca with a 100, Universidad del Valle with a 95, Universidad Icesi with 90.47, Harinera del Valle with 90.47 and the Universidad Javeriana with 90.47 (Table 3).

The positional indicators of degree indicate that in the depth relations network, Universidad Icesi, as a private higher education organization, is the actor with the greatest connectivity and representativeness that leads in the network with 13 relationships and 68% affinity in connectivity in the network. However, SENA also stands out, with 11 relationships and 57.89% affinity, and Universidad del Valle with 10 relationships and 52.63% affinity in the network, as relevant actors. The betweenness degree shows that the bridge actor with 126.3 and 36.9% is also Universidad Icesi, followed by other actors such as SENA with 90.5 and 26.46%, Gobernación del Valle del Cauca with 78.2 and 22.8%, Carvajal with 61.3 and 17.9% and Universidad del Valle with 56.9 and 16.6%. The degree of closeness shows

that the closest actors with the rest of the network is Universidad Icesi, with a 70. But SENA and Universidad del Valle can also be unleashed with proximity values of 67.8 and 65.5 respectively (Table 3).

For the positional analysis of breadth and depth relations, the indicators show that Gobernación del Valle del Cauca has an important role in the network of breadth relations. This is consistent because Gobernación del Valle del Cauca was the organization who led the policy formulation process and who promoted the interaction between the actors. In the depth relations Universidad ICESI is the organization who has an important role and depth relations with actors in business and high education sector.

Table 3. Positional indicators in the public policy of CSTI network

	Breadth	**Depth**
Degree	Gobernación del Valle del Cauca 19 (100%) Universidad Icesi = 18 (94.7%) Universidad del Valle = 18 (94.7%) Universidad Javeriana = 18 (94.7%) Harinera del Valle = 18 (94.7%)	Universidad Icesi = 13 (68.4%) SENA = 11 (57.9%) Universidad del Valle = 10 (52.6%)
Betweenness	Gobernación del Valle del Cauca 44.1 (12%) Universidad del Valle = 8.1 (2.3%) Universidad ICESI = 6.4 (1.9%) Universidad Javeriana = 6.4 (1.9%) Carvajal = 6.2 (1.8%) Harinera del Valle = 6.0 (1.7%)	Universidad Icesi = 126.3 (36.9 %) SENA = 90.5 (26.4%) Gobernación del Valle del Cauca = 78.2 (22.8%) Carvajal = 61.3 (17.9%) Universidad del Valle = 56.9 (16.6%)
Closenness	Gobernación del Valle del Cauca = 100 Universidad del Valle = 95 Universidad ICESI = 90.47 Harinera del Valle = 90.47 Universidad Javeriana = 90.47	Universidad ICESI = 70 SENA = 67.8 Universidad del Valle = 65.5

The breadth graph of the public policy of CSTI network of the Valle del Cauca (Figure 3), shows a network of horizontal and multicentric trend, the Gobernación del Valle del Cauca occupies a privileged and important position (government actor in the network), but it is not the only relevant actor in the network due to the relationship between other actors in the academy and the business sector.

The depth graph of the public policy of CSTI network of the Valle del Cauca (Figure 4), shows a network of horizontal and multicentric tendency, higher education institutions occupy a privileged and important position (mainly Universidad ICESI actor), but he is not the only relevant actor in the network given his level of relationship with other higher education actors and the business sector.
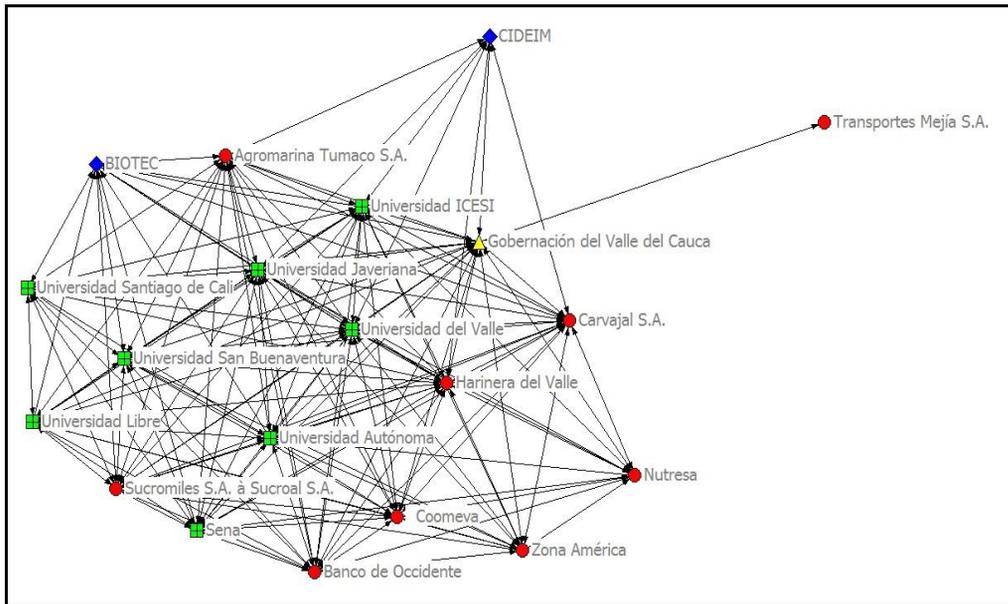
Figure 2. Breadth graph of the Public Policy of CSTI network of Valle del Cauca
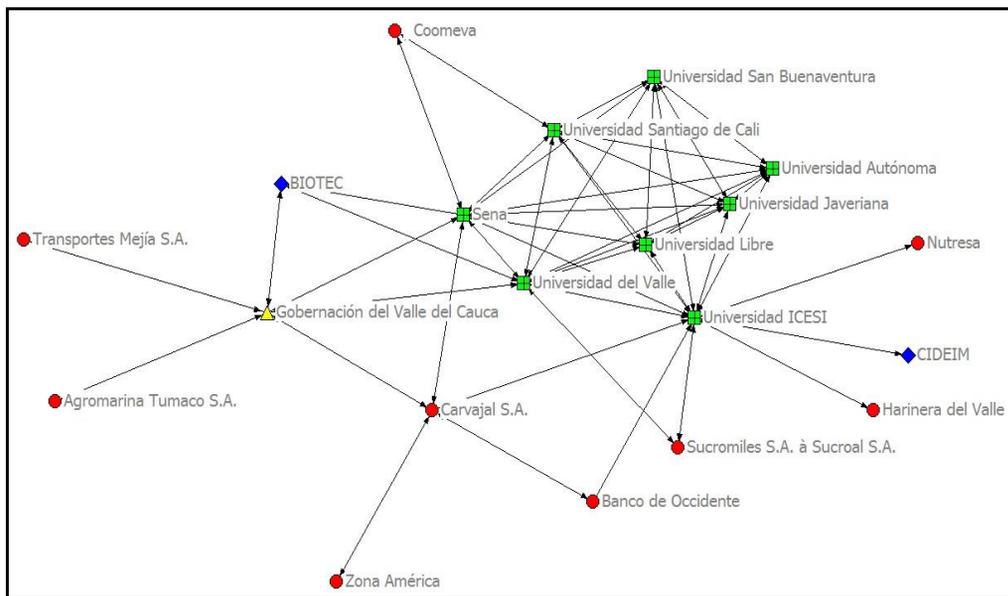
Figure 3. Depth graph of the Public Policy of CSTI network of Valle del Cauca

5. Conclusion

The systematization of the information allowed to know 20 main actors of open innovation that participated in the formulation of the public policy of CSTI of Valle del Cauca. Recognizing that the analysis is carried out from the open innovation at the inter-organizational level and in this sense, other actors such as committees, working groups, unions, clusters

and others conformed by organizations were excluded from the analysis.

The combination of quantitative and qualitative methods allowed us to understand the dynamics and network structure of the most relevant actors for the public policy, defining the structure according to the concepts of breadth and depth. The results showed that the majority of relations in the network are relations of breadth and in a much smaller proportion relations of depth. Highlighting that relations of depth are also relations of breadth, since the level of strength or depth has as its basic component a relation of breadth, that is, the existence of a link between two parts.

Although significant progress has been made in the Valle del Cauca department in relation to the degree of breadth, that is, the links between the actors, there is still a need to strengthen the levels of depth or strength in the relationships; advancing to relationships with greater commitment such as trust relationships where the actors share activities, resources, objectives and projects. The dynamics of the network indicate that in terms of breadth, the public policy network does not have a single actor that plays the central role and controls the entire network. However, it should be noted that the Gobernación del Valle del Cauca occupies a privileged and important position as a government actor, given that it has been the promoter and guiding organization of the public policy of CSTI of Valle del Cauca.

According to the results, it is possible to affirm that the Gobernación del Valle del Cauca occupies a central role, although not strictly because there are other important actors, but the process of public policy formulation show that Gobernación has allowed organizations to connect around complex and difficult problems, beyond individual skills, such as low levels of innovation. A network becomes much more than the sum of its parts and in this sense the public policy of CSTI of Valle del Cauca grouping different organizations allows a better approach to the problems and make the ecosystem work better.

In terms of breadth, the Gobernación has taken an essential role that could be described as a cornerstone as it constitutes a key piece to promote the development of the ecosystem, in terms of generating an environment conducive to the recognition of the different actors around the purpose of generating innovations that contribute to the competitiveness and development of the department. The cornerstone concept is especially important because ecosystems are usually characterized by frequent external disruptions that must be prevented in order to preserve the overall structure and in this sense the government sector plays a central role because as cornerstone has the potential to generate significant and lasting changes in an ecosystem, since while actors and interactions over time can change, the structure as a whole must persist and be guaranteed by the government.

In terms of depth, the results indicate that higher education institutions play a privileged position and specifically the Universidad ICESI as a relevant actor and with a greater degree of closeness between the actors. These results confirm that in-depth relationships tend to be established through contracts and trust relationships where activities, resources, objectives and projects are shared within the framework of specific actions and not as widespread as sporadic and simple meetings of what the other actors do. The depth relations require more than a simple meeting and in which, as evidenced by the results, the academic sector plays a decisive role both in the use of innovations and in achieving deep relationships between the actors specially through research projects.

The levels of greater depth require that the actors have gone through previous stages of recognition and knowledge among actors. To the extent that the actors know each other better, it is possible to establish relationships of trust that favor a stable dynamic over time, that is, that the actors advance to higher levels

such as projects where activities, resources and objectives are shared from breadth to depth relations.

6. Practical implications

The findings of this research suggest that the interaction spaces between different actors enable the creation of relationships, which, as they become deeper and based on trust, strengthen the structure of the network. Public policies should be used as mechanisms from which interaction spaces are created enabling different actors and interest groups related or affected by the problems participate in the discussion and generation of alternative solutions. Public policies should not simply be formulated from top-down approaches but should be geared towards generating spaces for interaction and building trust that allow a constant flow of information regarding the changing dynamics in relation to problems complexes facing society.

It has been shown in this research that depth relations in Valle de Cauca are scarce and therefore it would be valuable to examine how not simply to foster and accelerate the breadth of relations, but to deepen the levels of depth or strength. It is necessary to scale the different levels of consolidation, until reaching the maximum level in a network where a relationship of trust is established that allows the members of the network generate an association for the development of projects that are really aimed at shaping a true ecosystem or innovation system.

Therefore, it is urgent and timely for policy makers and researchers in this area not to wait, but to develop new policies and strategies for competitiveness and innovation based on open innovation approaches. These should address the double social and global challenges head on and contribute to the economic developing.

References:

Bogers, M., Zobel, A-K., Afuah, A., Almirall, E., Brunswicker, … , & Ter Wal, A. J. (2017). The open innovation research landscape: Established perspectives and emerging themes across different levels of analysis. *Industry & Innovation*, *24*(1), 8-40. doi: 10.1080/13662716.2016.1240068.

Cadiou, J. C., & Chené, E. (2017). Strengthening partnerships between universities and SMEs within the open innovation framework. In *Innovation and Interdisciplinary Solutions for Underserved Areas* (pp. 45-55). Springer, Cham. doi:10.1007/978-3-319-72965-7_4.

Chesbrough, H. (2003). *Open Innovation: The New Imperative for Creating and Profiting from Technology.* Harvard Business School Press, Boston.

Chesbrough, H. W., & Vanhaverbeke, W. (2018). Open Innovation and Public Policy in the EU with Implications for SMEs. *World Scientific Book Chapters*, 455-492.

Chesbrough, H., & Bogers, M. (2014). Explicating open innovation: Clarifying an emerging paradigm for understanding innovation. In H. Chesbrough, W. Vanhaverbeke, & J. West (Eds.), *New Frontiers in Open Innovation*: 3-28. Oxford: Oxford University Press.

Chesbrough, H., Vanhaverbeke, W., & West, J. (Eds.). (2006). *Open innovation: Researching a new paradigm*. Oxford University Press on Demand.

Coyle, D. (2018). *The culture code: The secrets of highly successful groups*. Bantam.

De Jong, J. P., Vanhaverbeke, W., Kalvet, T., & Chesbrough, H. (2008). *Policies for open innovation: Theory, framework and cases*. Tarmo Kalvet.

Dhanaraj, C., & Parkhe, A. (2006). Orchestrating innovation networks. *Academy of management review*, *31*(3), 659-669. doi: 10.5465/amr.2006.21318923

Etzkowitz, H., & Leydesdorff, L. (2000). The dynamics of innovation: from National Systems and "Mode 2" to a Triple Helix of university–industry–government relations. *Research policy*, *29*(2), 109-123. doi: 10.1016/S0048-7333(99)00055-4.

Felin, T., & Zenger, T. (2014). Closed or open innovation? Problem solving and the governance choice. *Research Policy*, *43*, 914-925. doi: 10.1016/j.respol.2013.09.006.

Feller, J., Finnegan, P., & Nilsson, O. (2011). Open innovation and public administration: Transformational typologies and business model impacts. *European Journal of Information Systems*, *20*, 358-374. doi: 10.1057/ejis.2010.65.

Ferraris, A., Santoro, G., & Papa, A. (2018). The cities of the future: Hybrid alliances for open innovation projects. *Futures*. doi: 10.1016/j.futures.2018.03.012.

Garcia Martinez, M., Lazzarotti, V., Manzini, R., & Sánchez García, M. (2014). Open innovation strategies in the food and drink industry: determinants and impact on innovation performance. *International Journal of Technology Management*, *66*(2-3), 212-242. doi: 10.1504/IJTM.2014.064588.

Gascó, M. (2017). Living labs: Implementing open innovation in the public sector. *Government Information Quarterly*, *34*(1), 90-98. doi: 10.1016/j.giq.2016.09.003.

Iansiti, M., & Levien, R. (2002). *The new operational dynamics of business ecosystems: Implications for policy, operations and technology strategy*. Boston, MA: Division of Research, Harvard Business School.

Kube, M., Hilgers, D., Koch, G., & Füller, J. (2015). Explaining voluntary citien online participation using the concept of citizenship: an explanatory study on an open government platform. *Journal of Business Economics*, *85*(8), 873-895. doi: 10.1007/s11573-014-0756-y.

Laursen, K., & Salter, A. (2006). Open for innovation: the role of openness in explaining innovation performance among UK manufacturing firms. *Strategic management journal*, *27*(2), 131-150. doi: 10.1002/smj.507.

Leiponen, A., & Helfat, C. E. (2010). Innovation objectives, knowledge sources, and the benefits of breadth. *Strategic Management Journal*, *31*(2), 224-236. doi: 10.1002/smj.807.

Lopes, A. P. V. B. V., & de Carvalho, M. M. (2018). Evolution of the open innovation paradigm: Towards a contingent conceptual model. *Technological Forecasting and Social Change*, *132*, 284-298. doi: 10.1016/j.techfore.2018.02.014.

Loukis, E., Charalabidis, Y., & Androutsopoulou, A. (2017). Promoting open innovation in the public sector through social media monitoring. *Government information quarterly*, *34*(1), 99-109. doi: 10.1016/j.giq.2016.09.004.

Marsh, D., & Smith, M. (2000). Understanding policy networks: towards a dialectical approach. *Political studies*, *48*(1), 4-21. doi: 10.1111/1467-9248.00247.

Martínez, J. I. P. (2001). Policy Network o red de políticas públicas: una introducción a su metodología de investigación. *Estudios sociológicos*, 721-745.

Mergel, I., & Desouza, K. C. (2013). Implementing open innovation in the public sector: The case of Challenge.gov. *Public Administration Review*, *73*(6), 882–890. doi: 10.1111/puar.12141.

Muñoz, R. A. T. (2016). El análisis organizacional y de política pública a partir del enfoque de redes. *Tendencias*, *17*(2), 4. doi: 10.22267/rtend.161702.4.

Pollitt, C., & Hupe, P. (2011). Talking about government: The role of magic concepts. *Public Management Review*, *13*(5), 641-658. doi: 10.1080/14719037.2010.532963.

Roper, S., Vahter, P., & Love, J. H. (2013). Externalities of openness in innovation. *Research Policy*, *42*(9), 1544-1554. doi: 10.1016/j.respol.2013.05.006.

Silva, M. J., Leitao, J., & Raposo, M. (2008). Barriers to innovation faced by manufacturing firms in Portugal: how to overcome it for fostering business excellence? *International Journal of Business Excellence*, *1*(1-2), 92-105. doi: 10.1504/IJBEX.2008.017568.

Sørensen, E., & Torfing, J. (2011). Enhancing collaborative innovation in the public sector. Administration and Society, *43*(8), 842–868. doi: 10.1177/0095399711418768.

Teja Gutiérrez, R., Almaguer Vargas, G., Rendón Medel, R., & López Lira, N. (2014). Redes Y Análisis Organizacional: Roles, Posiciones Y Poder De Fragmentación De Las Relaciones Sociales Y Comerciales (Networks and Organizational Analysis: Roles, Positions and Power of Fragmentation of Social and Commercial Relationships). *Revista Global de Negocios*, *2*(1), 11-39.

Traitler, H., & Saguy, L. S. (2009). Creating successful: innovation partnerships. Food technology, *63*(3), 22-35.

Martha Lucia Agredo Díaz	**Frank Alexander Ramírez Ordoñez**	**Raúl Andrés Tabarquino Muñoz**
Universidad del Valle, Cali, Colombia	Universidad del Valle, Cali, Colombia	Universidad del Valle, Cali, Colombia
Martha.agredo@correouniv alle.edu.co	Frank.ramirez@correouniv alle.edu.co	Raul.tabarquino@correouniv alle.edu.co

Appendix I: Breadth matrix of the open innovation in the Valle del Cauca

Organizaciones	1. Agromarina Tumaco S.A.	2. Banco de Occidente	3. Carvajal S.A.	4. Coomeva	5. Harinera del Valle	6. Nutresa	7. Sucroal S.A.	8. Transportes Mejía S.A.	9. Zona América	10. Gobernación del Valle del Cauca	11. Sena	12. Universidad Autónoma	13. Universidad del Valle	14. Universidad ICESI	15. Universidad Javeriana	16. Universidad Libre	17. Universidad San Buenaventura	18. Universidad Santiago de Cali	19. BIOTEC	20. CIDEIM
1. Agromarina Tumaco S.A.		0	1	0	0	0	1	0	0	1	1	1	1	1	1	1	1	1	1	1
2. Banco de Occidente	1		1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	0	0
3. Carvajal S.A.	1	1		1	1	1	1	0	1	1	1	1	1	1	1	0	1	0	1	1
4. Coomeva	1	1	1		1	1	1	0	1	1	1	1	1	1	1	1	1	1	0	0
5. Harinera del Valle	1	1	1	1		1	1	0	0	1	1	1	1	1	1	1	1	0	1	1
6. Nutresa	0	1	1	1	1		0	0	0	1	1	1	1	1	1	0	0	0	0	0
7. Sucroal S.A.	1	1	1	1	1	0		0	0	1	1	1	1	1	1	1	1	1	1	0
8. Transportes Mejía S.A.	0	0	0	0	0	0	0		0	1	0	0	0	0	0	0	0	0	0	0
9. Zona América	0	1	1	1	1	1	1	0		1	0	1	1	1	1	1	1	0	0	0
10. Gobernación del Valle del Cauca	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1
11. Sena	1	1	1	1	1	1	1	0	0	1		1	1	1	1	1	1	1	1	0
12. Universidad Autónoma	1	1	1	1	1	0	1	0	1	1	1		1	1	1	1	1	1	1	0
13. Universidad del Valle	1	1	1	1	1	1	1	0	1	1	1	1		1	1	1	1	1	1	1
14. Universidad ICESI	1	1	1	1	1	1	1	0	1	1	1	1	1		1	1	1	1	1	1
15. Universidad Javeriana	1	1	1	1	1	1	1	0	1	1	1	1	1	1		1	1	1	1	1
16. Universidad Libre	1	1	0	1	1	0	1	0	1	1	1	1	1	1	1		1	1	1	0
17. Universidad San Buenaventura	1	1	1	1	1	0	1	0	1	1	1	1	1	1	1	1		1	1	0
18. Universidad Santiago de Cali	1	1	0	1	1	0	1	0	0	1	1	1	1	1	1	1	1		1	0
19. BIOTEC	1	0	1	0	1	0	1	0	0	1	0	0	1	0	0	0	1	1		0
20. CIDEIM	1	0	1	0	1	0	0	0	0	1	0	0	1	1	1	0	0	0	0	

Appendix II: Depth matrix of the open innovation in the Valle del Cauca

Organizations	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.
1. Agromarina Tumaco S.A.		0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
2. Banco de Occidente	0		1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
3. Carvajal S.A.	0	1		0	0	0	0	0	1	1	1	0	0	1	0	0	0	0	0	0
4. Coomeva	0	0	0		0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0
5. Harinera del Valle	0	0	0	0		0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
6. Nutresa	0	0	0	0	0		0	0	0	0	0	0	0	1	0	0	0	0	0	0
7. Sucroal S.A.	0	0	0	0	0	0		0	0	0	0	0	1	1	0	0	0	0	0	0
8. Transportes Mejía S.A.	0	0	0	0	0	0	0		0	1	0	0	0	0	0	0	0	0	0	0
9. Zona América	0	0	1	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0
10. Gobernación del Valle del Cauca	1	0	1	0	0	0	0	1	0		1	0	1	0	0	0	0	0	1	0
11. Sena	0	0	1	1	0	0	0	0	0	1		1	1	1	1	1	1	1	1	0
12. Universidad Autónoma	0	0	0	0	0	0	0	0	0	0	1		1	1	1	1	1	1	0	0
13. Universidad del Valle	0	0	0	0	0	0	1	0	0	1	1	1		1	1	1	1	1	1	0
14. Universidad ICESI	0	0	0	0	1	1	1	0	0	0	1	1	1		1	1	1	1	0	1
15. Universidad Javeriana	0	0	0	0	0	0	0	0	0	0	1	1	1	1		1	1	1	0	0
16. Universidad Libre	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1		1	1	0	0
17. Universidad San Buenaventura	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1		1	0	0
18. Universidad Santiago de Cali	0	0	0	1	0	0	0	0	0	0	1	1	1	1	1	1	1		0	0
19. BIOTEC	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0		0
20. CIDEIM	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	