UNIVERSIDAD DEL ROSARIO

Key Factors for Innovation: Analysis of Colombia's service industry

Trabajo de Grado

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Bogotá, Colombia

2019-II

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ABSTRACT

Due to the changing environment and uncertainty in which companies are, they have now the obligation to do innovation. There are many reasons to innovate, and also different ways. Firms have an open scope of possibilities and there are existing factors that can affect the innovation performance. This paper aims to identify which are the key success factors to innovate in Colombia in the services industry. Considers variables such as internal collaboration, external collaboration, R&D investment and team conformation. A statistical analysis and logistic regression were performed. However, there are important limitations to consider in an upcoming study.

Key words: Innovation, Services, Colombia, Key Factors

RESUMEN

Debido al entorno cambiante y la incertidumbre en que se encuentran las empresas, ahora tienen la obligación de hacer innovación. Hay muchas razones para innovar, y también diferentes maneras. Las empresas tienen un alcance abierto de posibilidades y existen factores que pueden afectar el rendimiento de la innovación. Este documento tiene como objetivo identificar cuáles son los principales factores de éxito para innovar en Colombia en la industria de servicios. Considera variables como la colaboración interna, la colaboración externa, la inversión en I+D y la conformación de equipos. Se realizó un análisis estadístico y una regresión logística. Sin embargo, hay limitaciones importantes a considerar en un próximo estudio.

Palabras Clave: Innovación, Servicios, Colombia, Factores Clave

1. Introduction

Nowadays, companies face a changing environment and uncertainty, and they should adapt to it through multiple strategies, including the development of new products. The competition becomes increasingly harsh, and it is necessary to find alternatives to face the turbulent environment in order to survive.

The 2019 World Innovation Index, published by WIPO, Cornell University and other allies, highlights 20 leading countries in the field, starting with China. More than 50% of these countries are European, which allows to conclude that innovation is not a recurrent theme at least in Latin America. However, countries such as South Africa, which according to the World Bank has a GDP growth lower than Colombia (0.6% vs. 2.7%) stands out as the engine of innovation. Mexico also stands out for having a progressive increase in the ranking, which also drives the region. However, it is the only country in Latin America that stands out in the study (WIPO, 2018a).

It would be a lie to say that companies in Colombia do not innovate. According to WIPO, in 2016 Colombia had 978 granted patents vs. 2017, where it had 1232, representing an increase of approximately 25.97% (WIPO, 2018b).

However, a survey conducted by Azul Innovation & Business Growth and High Results, assured that, in Colombia, 33% of CEO interviewed affirm that the culture of innovation within their companies is low, and therefore, they are not given the importance required to meeting the

strategic objectives (Portfolio, 2015).

Most innovation studies in Colombia are from before 2010, so it is considered relevant and useful to do this study. However, it is necessary to recognize the government's effort to include innovation since 2007 in its agenda, and from 2010 in the National Development Plan (Villa, L & Melo, J, 2015).

The question now is which are those important key aspects that a firm needs to consider when doing an innovation process in order to have a successful delivery of it.

1.1 Problem definition

It is known that innovation is needed to survive in any industry and that the world now demands to be at the forefront of implementing new technologies and thus, discover different ways of doing things.

Topics such as internal collaboration, external collaboration, the investment for R&D activities, proximity to partners, have been taken into account to explain the degree of innovation of different companies. However, it is not known for sure what are the factors that directly affect and whether these factors have changed since 2014 in Colombia.

A study conducted by Julia Clemencia Naranjo and Gregorio Calderón determines that often, the innovation processes of companies in Colombia are done in a way not planned or strategic, but adrift.

2. Literature Review

Today, companies face a changing and turbulent environment, which forces them to be innovative and create products of better quality and more frequently. The literature review can be based on two theories that will be the basis of this research. The first of these is network theory of firms in which it is emphasized that a company is not isolated in the middle of the competitive environment but is closely related to others through networks. For example, who is a supplier of one company is a client of another. The other theory is that of Transaction Cost Analysis (TCA). This assumes that a company must look at the cost of outsourcing a function compared to the cost of doing it on its own. If the first one is bigger, you should not outsource. Based on these theories, we can define that there is a tendency to collaborate and to make a partnership with other companies that can offer better conditions to develop new products

The study of innovation of services started on 1990s by European scholars in a theoretical and empirical way. However, more importance was given to theory and not so much to the development and analysis of questionnaires. Because of this, European Community Innovation Survey (CIS) and the American Business R&D and Innovation Survey (SIRD) were created to

capture dimensions about innovation in services. (De Liso, N. & Serena, A., 2017). This could be compared to EDITS survey for Colombia which is explained later.

At times, the company is limited and notes that its own R&D team does not have the capabilities to carry out a process of new product development (NPD), so it resorts to collaboration. In the words of Bjørge Timenes Laugen and Astrid Heidemann Lassen, firms use collaboration to expand all their competences (2017). Business environment understands product innovation as "creation of novel product or product functions" (Chu, C., 2005).

Innovation is not an easy task and it has many things on which they depend. A study by Sheree Lloyd and other researchers from Australian health institutions concludes that organizational culture, support for innovation, leadership and a shared vision are essential ingredients for innovation (2018).

2.1 Internal Collaboration

Literature has made a division in collaboration in internal and external collaboration. Internal collaboration refers to using different activities that are developed within the value chain. It has been found that the suppliers and customers are not so important for new product development of radical products in B2C markets, so when they want to develop new radical products it is not done with the help of external collaboration (Timenes, B & Heidemman, A 2012).

A case in which it is evident is in LG Chem Research Park, the primary organization of R&D of LG Chem, a company of South Korea dedicated to produce chemical substances and basic materials to implement in technology of the information and electronics. They wanted to become open innovation, but they realized that they had to foment and adapt their internal innovation first since there was some resistance to open innovation (Sung-Mahn Lee and Juneseuk Shin, 2017). The above is related to the previous study because LG Chem Research Park works in B2B market, and for them there is no need to create a product by creating it quickly, but also by quality and to give the best products with the highest possible quality.

For this reason, they created programs such as i-OnePAd, I-Challenge and i-Expert as well as Communties of Technology (CoT) and Research Informals to promote innovation and internal collaboration. Thus, different people involved in the value chain of the company dared to collaborate and uninhibited in front of the open collaboration. Nowadays, the company looks for solutions internally and subsequently, abroad (2017).

Additionally, in the financial sector, frontline employees, the team of employees responsible for service development and the CEO as a source of innovation are important (Martovoy, A. et al, 2015).

2.2 External Collaboration

There is a direct relationship between the external networks of work (the way the company relates to agents outside of them) and its performance in innovation. In addition, it is stated that when there are turbulent environments and competition is intense, companies are more motivated to make innovation because growth and competitiveness strategies are established in order to survive (Sanchez, I et al, 2013).

Faced with external collaboration, most of the literature has analyzed the cases of the suppliers and the customers. As for the suppliers, David T. Rosell and Nicolette Lakemond realized an existing gap because although it is true that suppliers help develop new products, they did not know exactly what they contributed (2011). They conducted a literature research and were able to determine four ways in which suppliers are involved in the process: when the design is done by the client, when the suppliers are involved in the design and can impact, when the suppliers are involved in the process. process with low dependency and impact to the project in general and when the suppliers do the whole NPD process. This study expands and focuses on the degree to which a supplier may be involved with the new product development process (Rosell, D & Lakemond, N., 2011).

There is another study that shows that when there is technological collaboration with suppliers there is a greater propensity to develop new products. In addition, it was shown that medium-sized companies are the ones that make radical innovations, that is, those of greater

uncertainty and risk. This study was conducted in the manufacturing industry in Spain, which limits the scope of the study.

The other part of the external collaboration stream involves the customers. A study found that its evident that customers do not always know the radicality of new products (Timeness, B and Heidemann, A, 2017, p.459). One way to collaborate to create new products with customers is by using internet as a platform for customer engagement. By taking them into account in a virtual environment, the customer without physical proximity can bring to the company important input about the requirements and needs of the customers as a whole, speeding up the process and lowering the costs at the front end of NPD (ideation and concept) and / or at the back-end (product design and testing). This was the case of Ducati Motor in the motorcycle industry and Eli Lilly in the pharmaceutical industry (Sawhney, M. et al, 2005).

Collaborating with customers to innovate should be analyzed depending on the situation. For example, in the financial industry collaborating with customers is not easy due to the complexity of financial products (Martovoy, A. et al, 2015). It is a little difficult for people to understand these products in depth, so their interest decreases. Therefore, doing this type of collaboration would not have a greater impact on the company's strategy as the real needs of the customers would not be met. This is just one example and may not be applicable in all cases, as your study supports that customers have medium importance as source of innovation.

A study conducted by David Doloreux, Richard Shearmur and Mercedes Rodriguez affirms that using the customers as a source of innovation is useful when the firm wants to do marketing

innovation but isn't when the firm does product innovation. Additionally, it says that collaborating externally with clients, suppliers, investors, conferences and internet have a greater probability to innovate compared with collaboration with universities and consultants (2018).

People might think that collaborating with competition is not an appropriate strategy as those ideas that are intended to impact the market would be shared. However, a study conducted by John Strickland completely states the opposite, which says it "can lead to reductions in cost, schedule and risk that could never otherwise be considered possible" (Strickland, J., 2010).

With information gathered in Spain and Europe, researchers conclude that the valuable information as a source for external collaboration are customers and end users, without considering the firm's size. Also, firms that collaborate externally with these types of partners have a greater budget for innovative and R&D activities (Sánchez, G. & González, N., 2007).

Typically, industries like finance tend to have stronger external collaboration than internal collaboration. In an analysis of existing literature, Andrey Martovoy, Anne-Laure Mention and Marko Torkkeli found that, within this industry, the will to innovation is essential. While there are certain institutions that believe that the best way to survive is to copy what competition does, other financial institutions think that new products need to be made and its necessary to innovate in delivery methods (2015).

For banks, collaborative work with other banks or other entities belonging to a bank's group is of high importance. In addition, among the possible outcomes that are available through external

collaboration are increase customer satisfaction, employees learned new skills and gained access es ideas, knowledge, expertise and technologies available at other partners (Martovoy, A. et al, 2015).

As key factors driving innovation, for there to be external knowledge flow in the financial sector, are hiring new personnel, purchase of machinery and equipment and informal personal interactions, which allows to conclude that the most important things is to have the technology and people's mindset (Martovoy, A. et al, 2015).

Collaborate with external partners is of utmost important because is necessary to form a series of network projects to develop innovation projects where “networks are integrated for value construction, in addition to competitive strengthening” (Jiménez, A. et et 2016). It’s about getting new thoughts and skills to obtain and take advantage of opportunities to improve business. Also, it is a way to “show the strong willingness to complement internal innovation capabilities” (Li, X., Gagliardi, D., & Miles, I., 2019).

2.3 R&D Team

It is to be assumed that the limitations of collaboration for innovation can be overcome because there is a tendency to form Virtual R&D Teams where people involved work together for product development (Ale, N, 2015, p.1). This could mean that the physic and time barriers can be

broken down to avoid them through those teams. It's also important to consider that "the managers of virtual R&D teams may concentrate on the process of NPD in the teams rather than equipping the teams with the latest technology of employing the over-qualified experts for NDP" (Ale, N, 2015, p.20).

In addition to this, it is necessary that managers and their team be innovation-oriented, not afraid of change, maintain optimal communication channels. It is concluded that a combination of three factors is necessary: information, technology and communication (Lloyd, S., 2018).

An analysis conducted by Fahri Ozsungur points that the "ethical leadership has a significant effect on innovation" (2019). This means that the leader mindset affects directly to the willingness of innovation of the people in the firm. These means to have open communication and when taking decisions, include all the team that its involved, so people aren't seen as machines but as important assets. For Cho, Y.H. and Lee, J, cited in Ozsungur's work, ethical leaders are "those who demonstrate honest, trustworthy and fair behavior and who are trying to influence their followers" (2019). It is key to pay attention to this role as it can have very interesting and important results for the development of innovation.

2.4 The risk of collaboration

Not all processes with customers are risk free. A study conducted by Xuefeng Zhang, Yu

Yang and Juafu Su, found 7 risk factors classified into 3 broad categories: Customer collaborative product development (CCPD), information communication and expression among customers and professionals and task-resources-objects coordination and scheduling. The risk factors can be evaluated and assessed through a method proposed by the authors which is later tried with customer collaboration (2015).

When firms are collaborating, it is not only important to find the ideal partner, but also to make a constant evaluation of the productivity of the collaboration. A study conducted by Guenther Schuh and four other authors, showed that there was no formal model to evaluate the productivity of the collaboration. For this, they designed a model based on the three constraints of project management (time, cost, quality) and adaptability, as well as a series of subordinate objectives. In the end, a target was developed that evaluates these four items and also explains the difference of the situations before and after the collaboration (Scuch et al, 2018).

2.5 Does proximity matters

Taiwan's case study would be contradictory to the above. This is because if there are virtual R&D teams, it is because local proximity is not necessary since new technologies allow those advantages.

Companies like Accenture, digital consulting, help companies find technological solutions

by adapting the technology capabilities of one country in another by the global network in which the company is immersed.

It’s common to think that collaborating with a partner with proximity is in the best interest of the organization. However, a study conducted by Sjoerd Beugelsdijk and & Cornet, S. shows that there is no evidence that collaborating with a close partner has a greater impact than with a company located further away. What really matters is being close to a university of technology. This suggests that space is a conception of each company and that sometimes "a far friend may be worth more than a Good neighbor" (2002). Nevertheless, this study was being conducted in the Netherlands, which considering its size, could have limitations.

In fact, there is a strong relationship between international sources of knowledge for innovation and the innovation performance. In contrast, the relationship between firms and local or national sources for innovation is not supported by the data (Cotic, A. & Prodan, I., 2008).

2.6 Which is the best strategy to innovate

Swink states that to be considered a true NPD process, different parts of the supply chain must be considered as level allies. According to the above, this could be achieved from internal collaboration and also external collaboration. A study made in Taiwan says that there is a unique strategy, in which they are geographically in proximity, but they also form a close relationship

with each other "(Chu, C., 2005). In fact, the concept of collaborative product development (CPD) has emerged (2005).

Innovation strategies should be considered depending on the type of service they offer. It is not the same to do innovation in the private sector as in the public sector. People who relate to a private company are customers, but those who are related to a private company are citizens (Arguelles, E & Villavicencio, D, 2018).

These differences are reflected in the way companies do innovation (Arguelles, E & Villavicencio, D., 2018). One of those differences that are mentioned is that private companies try to maximize monetary profits while private companies, social profits. The differences also lie in organizational structures, organizational context, performance measures, relationship with beneficiaries and decision-making in different time horizons (Arguelles, E & Villavicencio, D., 2018).

Innovation can be done in different way and for different purposes. For example, a similar analysis made in Bolivia states that 40% of the firms that participated in the survey did innovation for new or significatively improved products or services, and 27% did innovation for new processes. Also, there was a tendency to introduce innovation output in the firm (74%), without considering if it was a new product or service in the national (24%) or international market (2%) (Foronda, C., 2018).

According to Navarro, Llisterri and Zuñiga, quotated in Carlos Foronda’s work, from a

Latin-American perspective, countries of this region are more likely to do innovation in processes rather than innovation in products. (Foronda, C., 2018). Still, the evidence from Bolivia states the opposite.

2.7 Why it's important to innovate

The innovation process has no magic formula. In fact, it is a continuous learning process where it will discover which is the best strategy. However, not everything can be left to the destination so managers should be able to establish which is the strategy that best fits the real situation of the company. In addition, it is worth acknowledging that innovation in services is a little more complicated, since innovation in products improve the features and functionalities. Instead, services are about thinking new business models that can disrupt the market.

As mentioned above, there are certain barriers and limitations that do not favor innovation. Having a part of the budget considered for R&D activities is vital, as it is essential to invest in technology and advances.

This is why the role of managers is fundamental. A study by Angelica Maria Jimenez, Marcos Cabarcas and Hugo Gaspar, states that the Health Care Institutions (IPS) in the coastal area of Colombia have a technological and innovation delay, since they are not managed in the proper way, saying that 31% of institutions do not have a specialized group focused on these projects (2016).

If there is no innovation, is not possible to achieve a differentiation of the competition, and if this is not done, it is very difficult to obtain a competitive advantage and nor a sustainable advantage. In Jimenez's words, "it is this incapacity that leads companies to stagnate and lose competitiveness (...) they simply will not be able to respond to the requirements of an increasingly demanding contemporary environment" (2016). It is not unknown that the environment becomes increasingly turbulent, which does not allow the identification of white spots on the market so that companies can differentiate from the others.

Innovating is a way to generate value, and it's that value that ultimately attracts and retains customers. Additionally, innovating is a way to democratize knowledge and can be useful for many people. In words of Maria Soledad Ramírez and Francisco-José García, “open science brings with it the possibility of shared co-construction and the generation of open innovation, to contribute to the public sphere as well as private contexts” (2018).

For a developing country, innovation in new and significatively improved services offers competitive advantages to exit traditional products and services such as commodities and tourism (Rubalcaba, L., 2015).

2.8 Other barriers to innovation

Also, there are theories that support that people become reluctant to change and that it must

be managed. Kurt Lewin's change model states that there are some phases regarding to change management. The first one is unfreezing, when change is a necessity and is immediate. The second one is movement, when people are starting to realize they have to change. It involves acceptance and moving away from resistance. The final phase is refreezing or crystallization, where the behavior is locked and managers should evaluate and consolidate improvements, reward progress and monitor and institutionalize change (Zand, E & Sorensen, R., 1975). People usually resist change by not wanting, not knowing and not being able.

Other barriers that may arise, in addition to resource scarcity, are inefficiency in innovation training processes, lack of qualified staff for innovation, and problems in managing change, the latter being the most important for IPS in Colombia (Jimenez, A. et al, 2016).

Also, the biggest obstacle to innovation relates to the high costs of technology and the recruitment of experts (2010), so it could be assumed that the R&D investment has a direct relationship with the degree of innovation.

It is also important to take into account the support of public entities such as the Government for innovation. In Colombia, especially in the health sector, there are restrictive policies with the use of technology, and the Ministry of Health, the entity responsible for the proper functioning of health organizations, has not driven innovation.

A study by Luis Rubalcaba defines that for developing countries obstacles such as human capital deficiencies and institutional lack of competence, are stronger than in developed countries

(2015).

Morgan Swink (2006) states that collaboration is not as easy as it is believed. There are barriers and limitations of physical and temporal, organizational and hierarchical as well as relational and cultural barriers. However, he also affirms that there is a way to overcome these inconveniences without leaving aside that they will pose a series of challenges for the company.

For example, a study of the health sector in the United States, conducted by Regina Herzlinger, states that in the face of customer-centered innovation, technology and business model, it can be hinded by 6 forces that affect innovation. These are industry players, funding, public policy, technology, customers and accountability (2006). These barriers can be overcome and companies such as MinuteClinic of Minneapolis and Hospital Corporation of America have managed to overcome those difficulties. The last company made innovation in business model, that "allowed it to consolidate the management of dozens of facilities and thereby realize economies of scale" (Herzlinger, 2006).

3. Methodology

3.1 DANE

DANE is the National Administrative Department of Statistics. It is a Colombian public

institution authorized and responsible for collecting information of different kinds, and then disclosing it to persons of general interest that subsequently serves as a basis for different organizations to investigate and make decisions.

Their mission, said by themselves, is to "plan, implement and evaluate rigorous processes of practice and statistical commodification at the national level" (DANE, 2018b). In addition, they are responsible for following certain international standards so that the information is collected and displayed in the best way.

All of the above is in order to support the "solution of the social, economic and environmental problems of the country" (DANE, 2018b) so that it is then used in the best way and allows to build a better country.

DANE divides the information collected through censuses to families and businesses as follows:

Figure 1. *DANE survey information topics*

Group	Topic
Economy	International trade, domestic trade, construction, national accounts, industry, labour market, prices and costs, tecncology and innovation, and transportation
Society	Culture, demographics & population, education, government, gender, poverty and living conditions, health, security and defense

Territory	Environment, agriculture, regional information, geostatistics

Source: Own elaboration with DANE data

Unsurprisingly, the topic *of technology and innovation* is the subject of which was used for this document.

3.2 EDITS

The acronym EDITS refer to the DANE's Survey on Technological Development and Innovation in Services. In the words of DANE, the objective of THE EDITS is to "characterize the dynamics of innovation carried out by the country's companies, as well as to analyze the use of public support instruments" (DANE, 2018a).

This survey contains approximately 630 variables in five chapters: innovation and impact on the company, investment in scientific, technological and innovation activities, financing of scientific, technological and innovation activities, related to these activities, relationships with different actors and cooperation for innovation, as well as intellectual property, quality certifications and technical standards respectively.

EDITS is carried out every two years by means of a virtual questionnaire (Annex 1). Information is available on the website, so it is public in scope and can be used for any purpose, especially academic.

The analysis unit of the survey and this study is the commercial and service company. The survey for the years 2014-2015 and 2016-2017 was used as a reference. While there is previous information, which would also be relevant for this analysis, these two years have the same inclusion criteria. In other words, the same requirements were used to know which type of company should be included in the analysis. Therefore, taking other data corresponding to other time periods would not be prudent as it would have errors. This means that 8651 are companies corresponding to 2016-2017 and 8056 from 2014-2015.

In front of the chapters, The I, II, IV, & V were used. This means that the financing of scientific, technological and innovation activities, as well as intellectual property, certifications and quality, technical standards and technical regulations are beyond the scope of this analysis.

3.3 Research Question

What are the factors that have affected innovation during the years 2014-2015 and 2016-2017 in service companies in Colombia?

3.4 Justification

Factors such as internal collaboration, external collaboration, budget for R&D activities, proximity to partners are known to have been analyzed from the literature in different specific industries, but there is no study cross-sector within the services industry that determines the degree of importance of these issues in innovation.

Moreover, as Colombia is an emerging and Latin American country, it is common to think that the potential for innovation is little. However, it is clear that as the years go by, innovation is an issue that takes on more strength because more organizations focus their efforts on it.

3.5 Study Description

The information presents both quantitative and qualitative variables. For this reason, the study will begin with a statistical description of the types of innovation by sector and by year. The dependent variables will then be analyzed separately by means of logistic regression and finally, the obstacles to innovating in Colombia will be discussed. Because there are two types of variables, measures such as correlation are not possible to obtain.

The tools used were Rstudio and Tableau. It is important to note that the information

obtained from DANE is in Spanish, so the translation was made by the author.

3.6 Logistic Regression Model

This type of regression is used for descriptive purposes. As mentioned above, it needs to be used as the data corresponding to the variables are mostly dichotomous. This means that it takes the value of 0 when the variable in question is not present, and 1 when it is.

The purpose of this logistic regression is, unlike linear regression, to predict the probability of the dependent variable occurring when dependent variables are known (Ferre, M., 2019).

The assumptions of the model are as follows (Ramos, F., n.d.):

- Statistical errors are independent
- Number of variables and number of answers: "It is not recommended with low number of participants since the estimate is not done properly and also distorts the interpretation" (Ramos, F., n.d.)
- Extreme values: these extreme values can reduce the predictive capacity of the regression

3.7 Dependent Variables

Dependent variables refer to the factors analyzed in this study:

- R&D Investment
- Internal collaboration
- External collaboration
- Team members

3.8 Independent Variables

The independent variable is whether the organization did innovation or not. DANE classifies innovation according to the following table:

Figure 2. *Types of innovation*

Innovation of new goods or services	New services or goods only for the firm
	New services or goods in the national market
	New services or goods on the international market
Significantly improved goods or	Significantly improved services or goods for the firm

services innovation	Significantly improved services or goods in the national market
	Significantly improved services or goods in the international market
Others	Introducing new or significantly improved processes for the firm
	Introducing new organizational methods
	Introduction of new marketing techniques in the company, with the aim of expanding or maintaining its market.

Source: Own elaboration with questionnaire information

3.9 Variables of control

The control variables are two years and service type. The first, as mentioned above, is divided into 2014-2015 and 2016-2017. The second is classified as follows:

Figure 3. *Total firms by service type by each year*

CIIU Code	Service type	Year	Total firms
35	Electricity, gas, steam and air conditioning supply	2014-2015	140
		2016-2017	97
36	Water collection, treatment and distribution	2014-2015	297
		2016-2017	191

37	Wastewater treatment and waste treatment	2014-2015	0
		2016-2017	144
45	Vehicle trade, maintenance and repair	2014-2015	316
		2016-2017	354
46	Wholesale	2014-2015	1515
		2016-2017	1723
47	Retail	2014-2015	1880
		2016-2017	2062
492	Public automotive land transport	2014-2015	0
		2016-2017	1209
51	Air transport	2014-2015	75
		2016-2017	68
53	Mail and courier services	2014-2015	1284
		2016-2017	57
55	Accommodation and food services	2014-2015	567
		2016-2017	729
58	Editing activities	2014-2015	142
		2016-2017	109
59	Cinematography, sound recording and music editing	2014-2015	23
		2016-2017	34
60	Programming, transmission and diffusion activities	2014-2015	39
		2016-2017	39
61	Telecommunications	2014-2015	168
		2016-2017	186
620	Development of computer systems and data processing	2014-2015	233
		2016-2017	253
641	Banking	2014-2015	23
		2016-2017	25
72	Research and Development Centers	2014-2015	66
		2016-2017	60

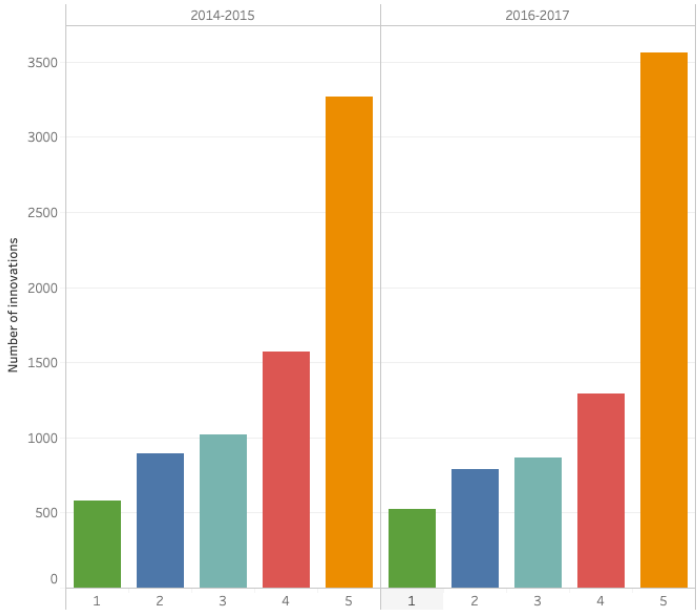
854	Higher education	2014-2015	231
		2016-2017	231
86	Human Health	2014-2015	1061
		2016-2017	1092

Source: Own elaboration with questionnaire information

4. Results & Analysis

4.1 Types of innovation

Figure 4. Number of innovations per innovation type

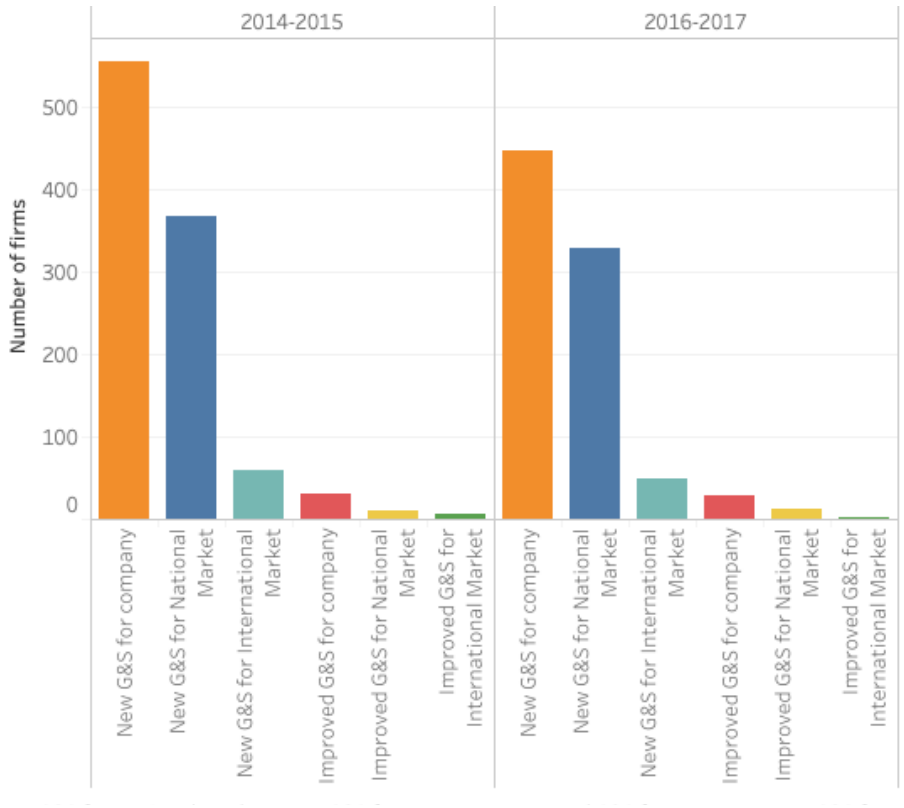


Source: Author elaboration based on EDITS results

In the chart above we can see the number of innovations in 2014-2015 and 2016-2017. It is to be noted that most companies made more innovation in new services or goods. This aspect, compared to the previous year, increased by 8.98% the number of innovations and the second-

highest type of innovation, the number of new or significantly improved process introductions accounted for 48.02% of the total number of new innovations in 2014-2015 and 36.21% in 2016-2017.

Figure 5. *Innovation for the company, for the national market and for the international market*



Source: Author elaboration based on EDITS results

The graph above shows the number of firms that does these different types of innovations. For this part, is only considered the goods or services that are new or significatively improved. The new products are understood as a product "whose fundamental characteristics are new in new respect to the corresponding previous products produced by the company (DANE, 2017).

On the other hand, significantly improved products or services are defined as products or services "whose performance has been greatly improved or improved" (DANE, 2017).

It can be observed that innovation in new and improved goods and services for the company lead in both segments. 7.77% of companies made innovation in new goods and services for 2014-2015 and 5.88% of companies in 2016-2017. This is the innovation group represented as number 1 on figure 4.

Regarding the goods and services significatively improved, 5,01% of the companies did this type of innovation for 2014-2015, and 4,61% firms in 2016-2017. In effect, there is enough evidence to confirm that the number of firms involved in these two types of innovation reduced among time.

Also, there was a tendency to introduce innovation output in the firm. Of the companies that responded that made innovation by introducing a new or significatively improved good or service for the firm, 89,62% introduced it in the firm by 2014-2015, and by 2016-2017, 89,29% did the same. For 2014-2015, 8,80% of the firms did innovation of new or significatively improved goods or services in the national market compared to 8,86% in 2016-2017. For last, the innovation of new or significatively improved goods or services for the international market was made by the 1,56% of the companies in 2014-2015 compared to 1,84% of the firms in 2016-2017. For both years, the tendency is very similar to the one in Bolivia, discussed by Foronda, C in the literature review.

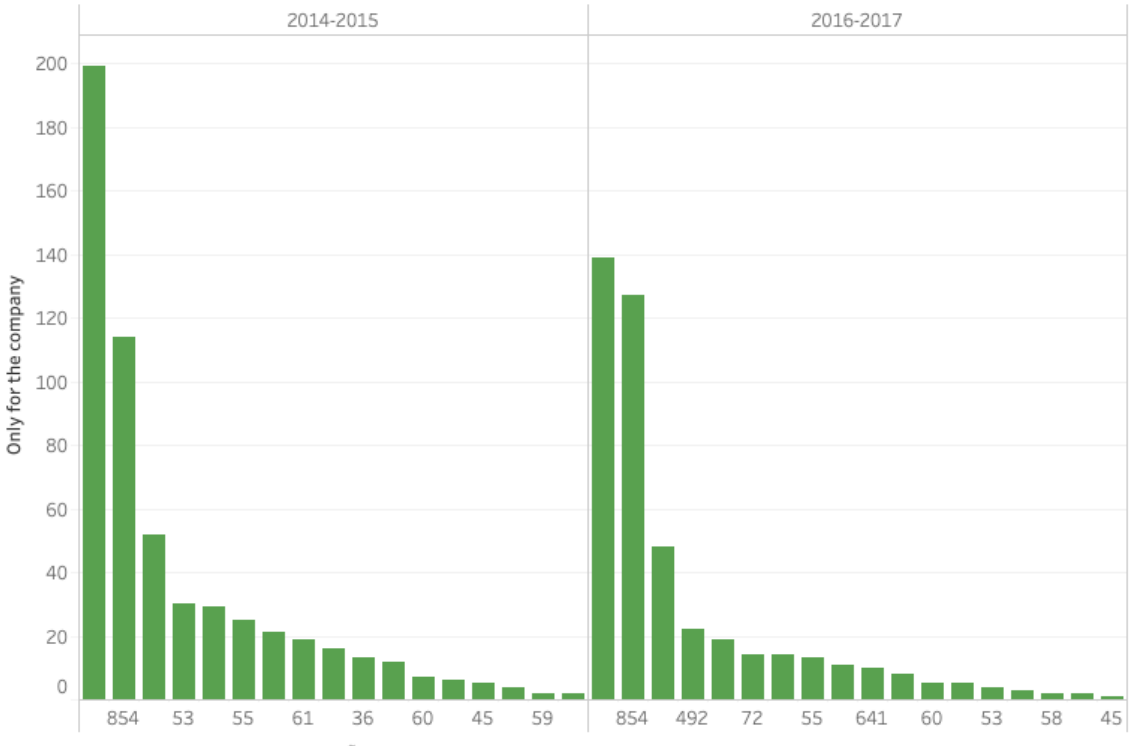
Figure 6. *Number of innovations per innovation type: first group*

Source: Author elaboration based on EDITS results

With respect to the first innovation group, it is clear that more innovation was made in the second year in Colombian service companies. This means that it is indeed an issue that is gaining strength and companies are paying more attention to it. The largest number of companies claim that they made innovation in new goods and services in the domestic market, which is directly beneficial to Colombia. The smallest number of innovations in this group was in the international market, which is supported by literature and innovation rankings explaining that Colombia is not a leader in innovation worldwide.

As for the first type of innovation, called Services or new goods only for the company in table 2, there is the following information:

Figure 7. *Number of firms innovating in new goods/services for the company by service type*



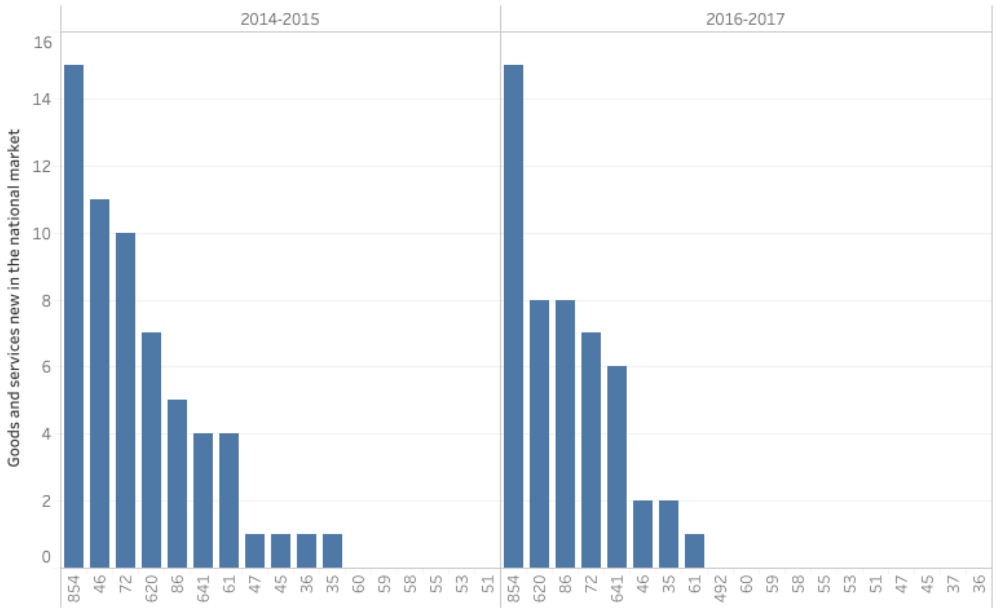
Source: Author elaboration based on EDITS results

The x-axis represents the CIU codes of each service (evidenced in table 3) and the x-axis, contains the number of companies that made this type of innovation for each year. It can be said that for the two years, companies in Human Health made more innovation. The data do not confirm the exposed theory that in the health sector it is very difficult to innovate. While there are certain obstacles, it was the most innovative service in Colombia in the periods 2014-2015 and 2016-2017. However, compared to the previous year, human health had a reduction in innovation for the company of 35.17%.

Higher education also had a high degree of innovation in new goods and services within the company and unlike human health, it had an 11.40% increase in 2016-2017. Service 45,

corresponding to Commerce, maintenance and repair of vehicles, is part of the least innovative sectors. This can be associated with the social object that these companies develop, since being standardized processes can hinder innovation. Also, air transport does not have a significant percentage of innovation services in this type of innovation. In addition, service 59, concerning Cinematography, recording of sound and music editing, had no record for the year 2016-2017.

Figure 8. *Number of firms innovating in new goods/services in the national market by service type*

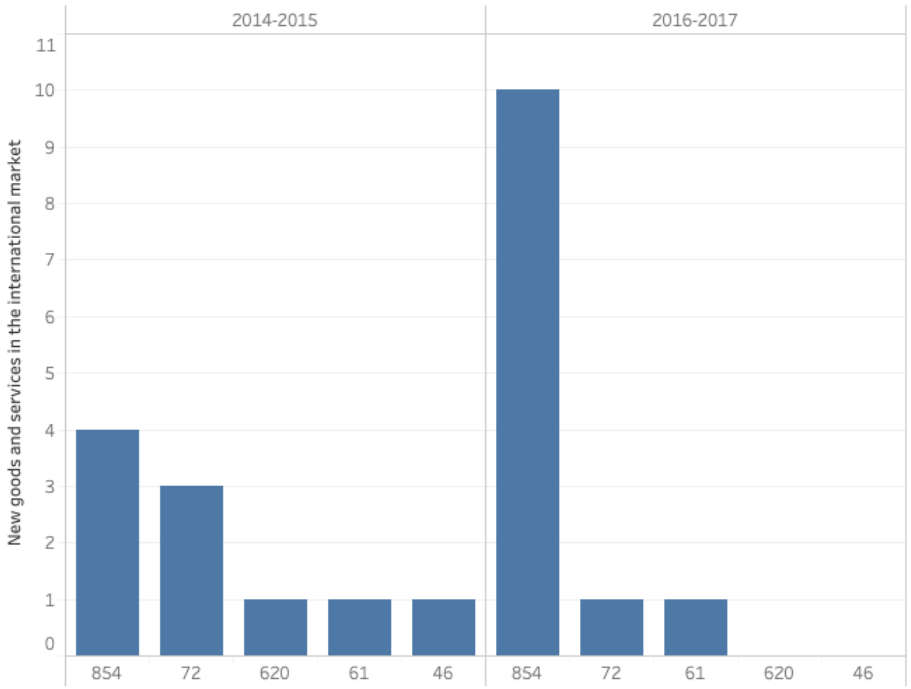


Source: Author elaboration based on EDITS results

The x-axis corresponds to the type of service offered and the axis and the number of companies that make innovation in goods and services in the national market. It can be seen that the greatest type of innovation of this kind is done by companies in charge of higher education (854), which were the highest scores in both years. On the other hand, a noticeable decline in innovation in wholesale trade (46) is observable as there was a reduction of 81.81%.

On the other hand, services of Programming Activities, Transmission and/or Diffusion (60), Cinematography, Sound Recording and Music Editing (59), Editing Activities (58), Accommodation and Food Services (55), Mail and Messaging Services (53), and Air transport (51) did not experience innovation of this kind in either year.

Figure 9. *Number of firms innovating in new goods and services in the international market by service type*

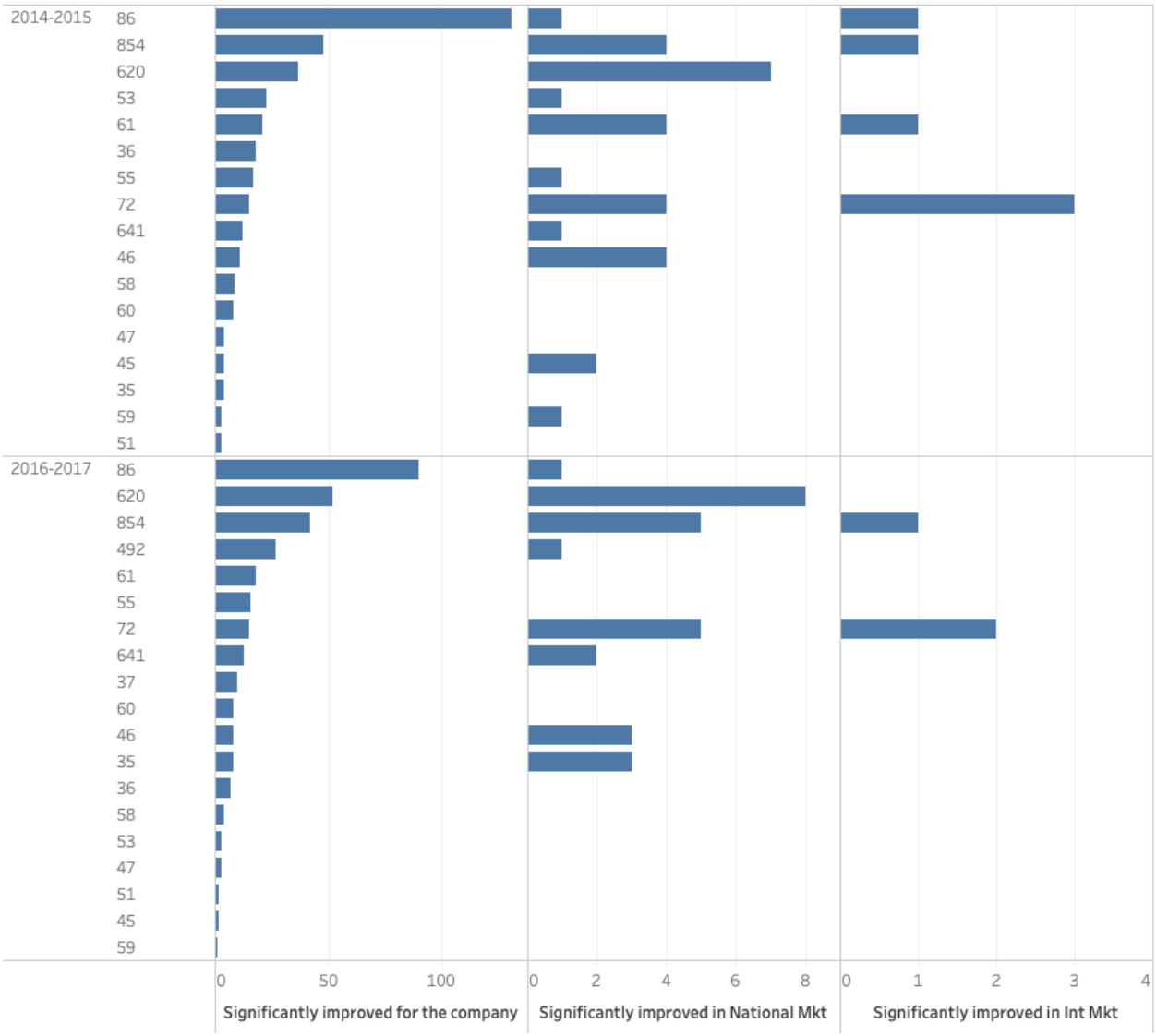


Source: Author elaboration based on EDITS results

El x-axis represents the service type offer by the firms, and the y-axis the number of firms innovating in new goods and services in the international market. The other types of services are excluded because there weren't results on those. It can be appreciated that this type of innovation is led by (854) Higher Education, followed by 72, Research and Development Centers. In the other hand, services 620 (Development of computer systems and data processing) and 46 (Wholesale)

had a complete reduction in 2016-2017.

Figure 10. *Innovation by type of service of the second group*



Source: Author elaboration based on EDITS results

The x-axis represents the different types of innovation in this group: significantly improved services or goods for your company, services or significantly improved goods in the national market and significantly improved services or goods in the international market. The y-axis refers to the service types discussed above and the comparison between the two time periods.

It can be observed that the type of innovation 86, corresponding to Human Health, were the leaders in the two time periods for significantly improved goods or services for the company. In the Second subtype, the leadership was 620, It Systems Development and Data Processing, with an increase of 14.20%.

As for the innovation of goods or services significantly improved for the international market, it is found that the companies dedicated to Research and development centers are the ones that make this type of innovation the most. In this regard, it is noteworthy that very few companies answer this question which rectifies that Colombia is not a leader in innovation worldwide.

It can then be concluded that when it comes to innovation in the company, independent whether new or significantly improved products and services, the companies that are most engaged in this type of innovation are those that specialize in Human Health (86), Higher Education (854) and Development of computer systems and data processing (620) for the two periods of analysis.

In addition, with respect to innovation in the national market for new or significantly improved goods or services, the largest number of companies engaged in Higher Education (854), Wholesale Trade (46), the Research Centers and Development (72) and the development of computer systems and data processing (620).

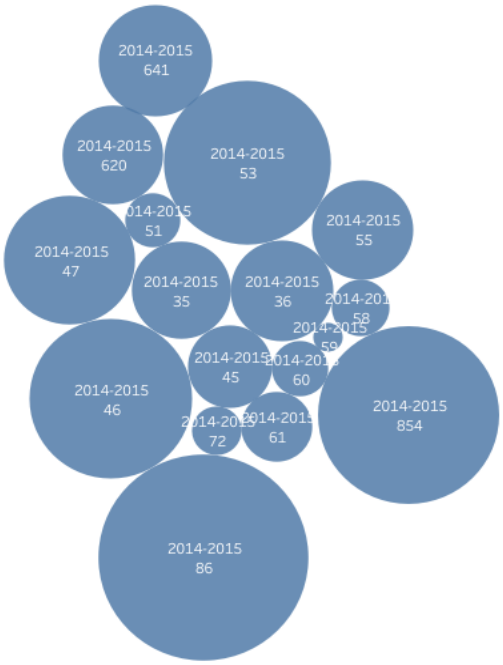
On the other hand, taking into account innovation in the international market for new or significantly improved goods and services, it is concluded that the types of service that make this innovation to a greater extent are Higher Education (854) and Research and Development Centers

(72).

It is important to note that the number of companies that answered the latest questions (domestic and international market) was much lower than those answered first (for the company). This concludes that companies in Colombia are not very interested in being leaders in national or international innovation. Indeed, they want to mark a competitive advantage with their closest competitors, introducing new products or services to their company, regardless of whether they already exist in the domestic or international market.

If they made more products or services for the domestic or international market the competitive advantage would be greater, because the degree of differentiation between companies would be even greater and the possibility of delivering more value would increase.

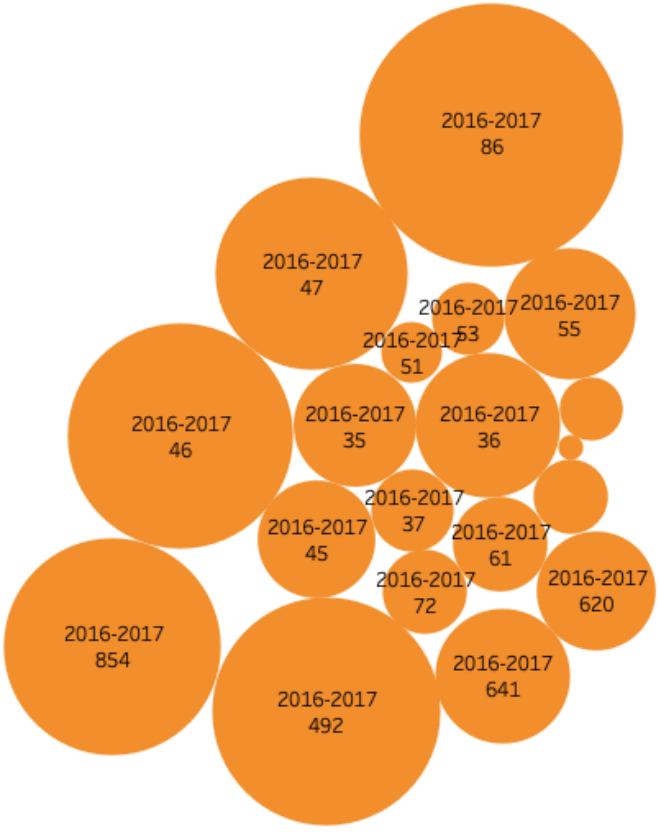
Figure 11. *Number of innovations by service type 2014-2015*



Source: Author elaboration based on EDITS results

The graph above shows the number of process innovations made by each type of service in the innovation of the introduction of "new or significantly improved processes, methods of service delivery, distribution, delivery or systems (DANE, 2017) for the period 2014-2015. It can be concluded that the types of service that make the most of innovation of this type are Human Health (86), Higher Education (854), Mail and Messaging Services (53) and Wholesale (46). Mail and messaging services are surprising because in previous types of innovation, it was not significantly relevant.

Figure 12. *Number of Innovations in processes by service type 2016-2017*



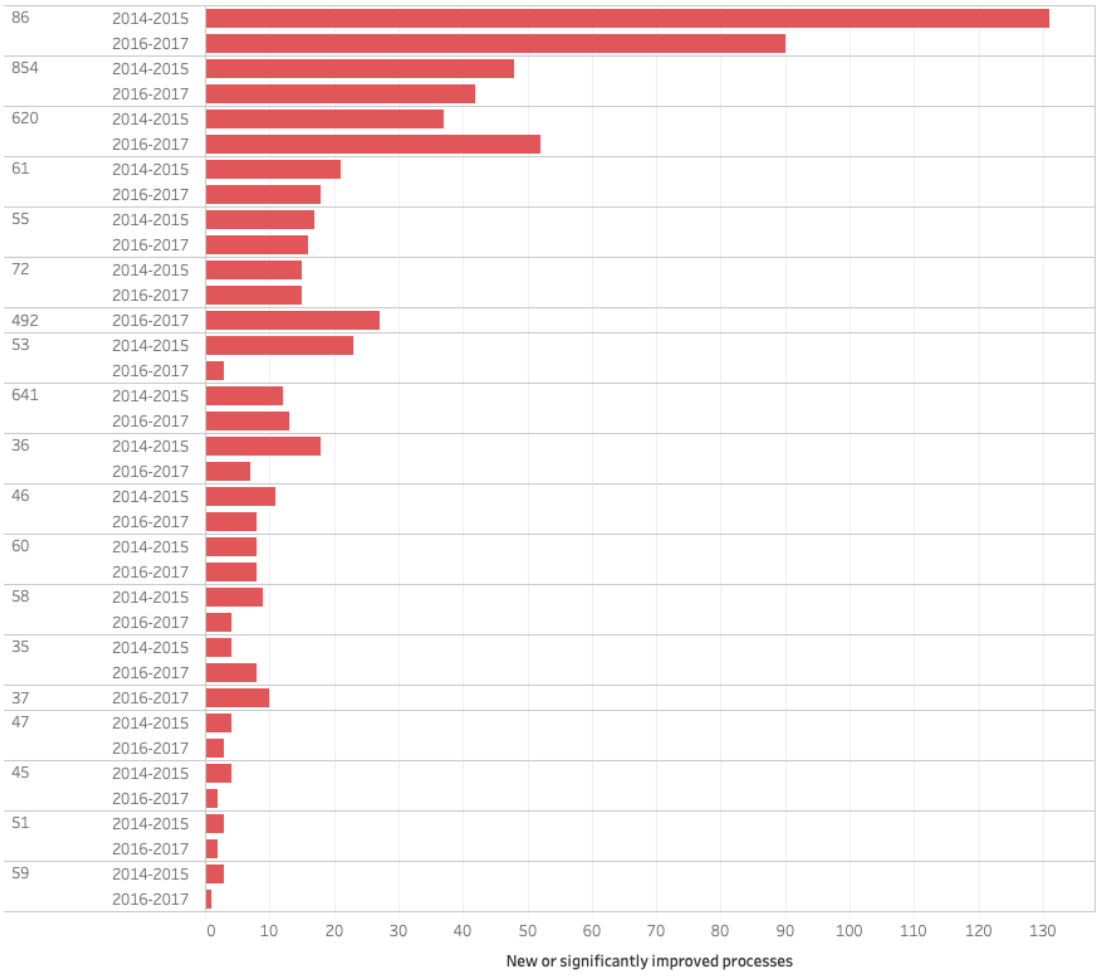
Source: Author elaboration based on EDITS results

The graph above shows the number of innovations in this same type of innovation by services for the period 2014-2015. It is possible to conclude that the firms that do the most innovation in this type are Human Health (86), Automotive Public Land Transportation (492), Higher Education (854), Wholesale Trade (46) and Retail (47).

It is notorious that the type of service 492, which corresponds to public automotive land transport, had an increase of 100% since no innovation of this type of innovation was recorded for the period 2014-2015. In 2016-2017, 169 innovations were made.

The type of Mail and Messaging Services (53) service had a noticeable decrease over time. It started with 193 such innovations in processes for the period 2014-2015 and ended with only 16 for 2016-2017, representing a decrease of 91.19%.

Figure 13. *Firms that do innovation in processes by service type 2014-2015 and 2016-2017*



Source: Author elaboration based on EDITS results

The graph above shows on the x-axis the number of companies that have made innovation in new or significantly improved processes and in the y axis, the service type related to table 3 and the two periods of time 2014-2015 and 2015-2016.

It is corrected that the above mentioned that the greater number of companies that make this type of innovation are part of services 86, 854, 620, in addition to the significant variation that service 53 suffered.

There is a trend that innovation of this kind decreased, evidenced in most services. The few services in which there is an increase are in the development of computer systems and data processing (620), Banking activities (641), and Supply of electricity, gas, steam and air conditioning (35).

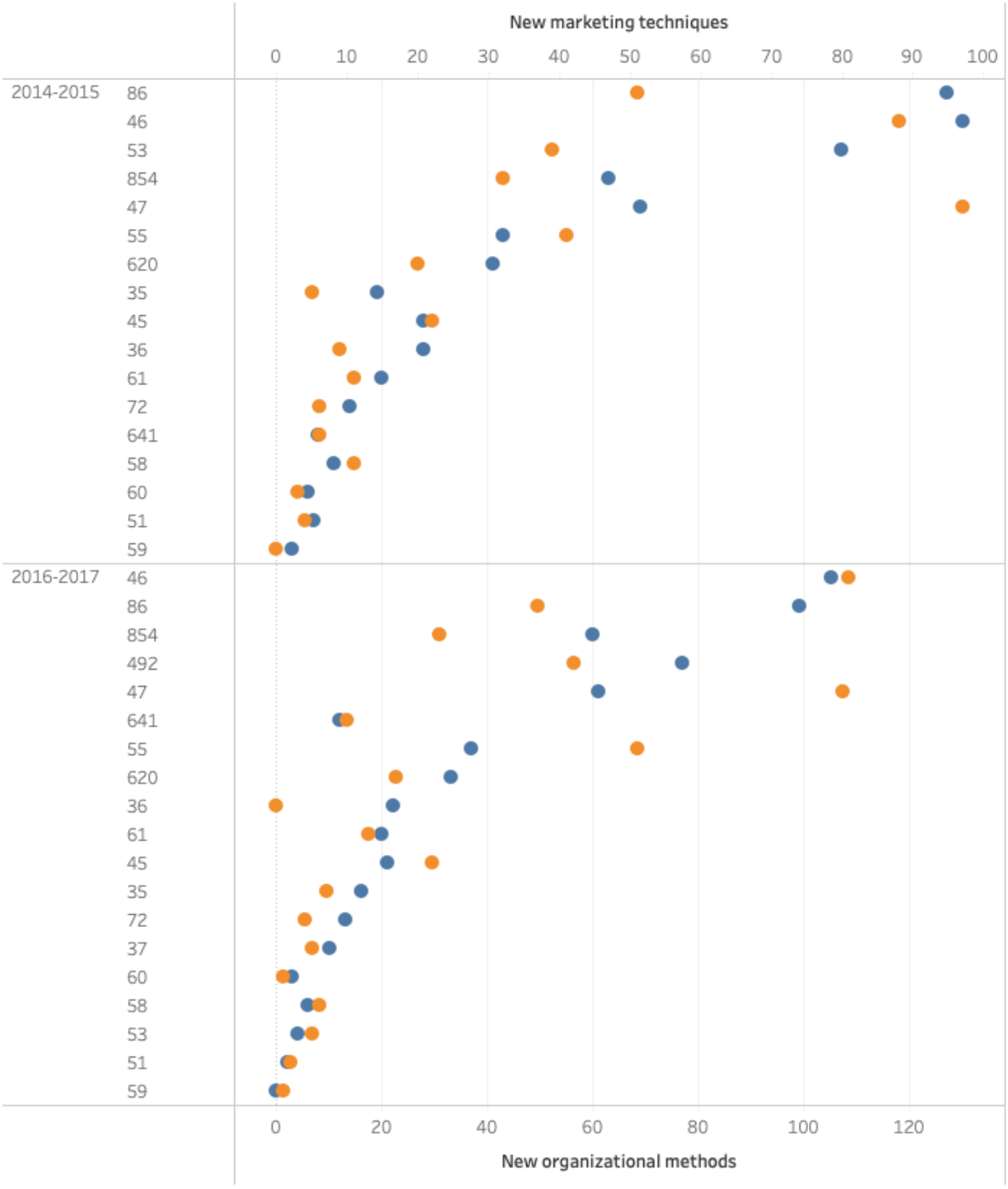
Regarding the "introduction of organizational methods implemented in the internal functioning of the company, in the knowledge management system, in the organization of the workplace, or in the management of the external relations of the company" (DANE, 2017) and the introduction of "new marketing techniques in your company" was made a chart representing the number of companies that carried out these types of innovation (Graph 7).

It is noted that during the two periods of time, the companies dedicated to Human Health (86) and Wholesale Trade (46) were leaders in innovation. The first type of service had greater innovation of new organizational methods in both periods although in both periods of time, the two types of innovation analyzed decreased.

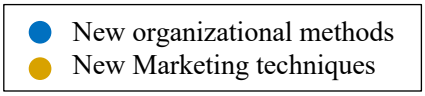
For wholesale, innovation in new marketing techniques decreased by an additional 10.11% to the decrease in innovation in new organizational methods a reduction of 16.66%, falling below the levels of innovation in new marketing techniques.

The services that have the least innovation of these types are those dedicated to Air Transport (51) and Cinematography, sound recording and music editing (59) with values very close to zero.

Figure 14. *New marketing techniques and new organizational methods by service type*



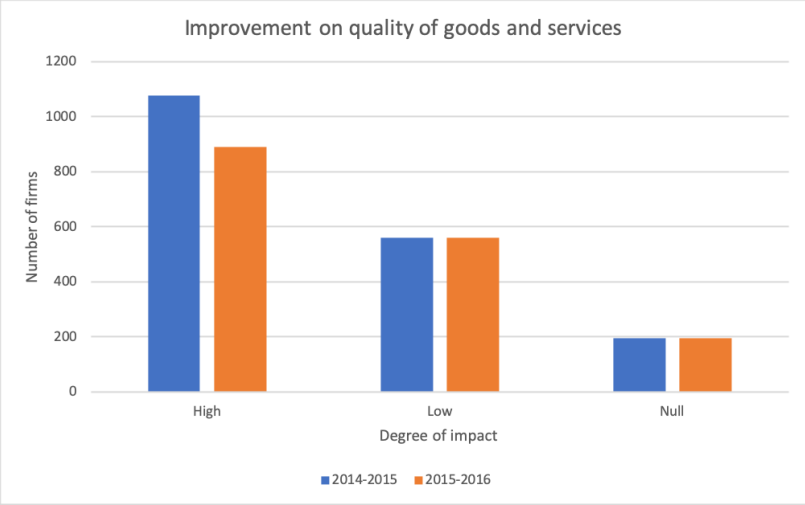
Source: Author elaboration based on EDITS results



4.2 Why it is important to innovate

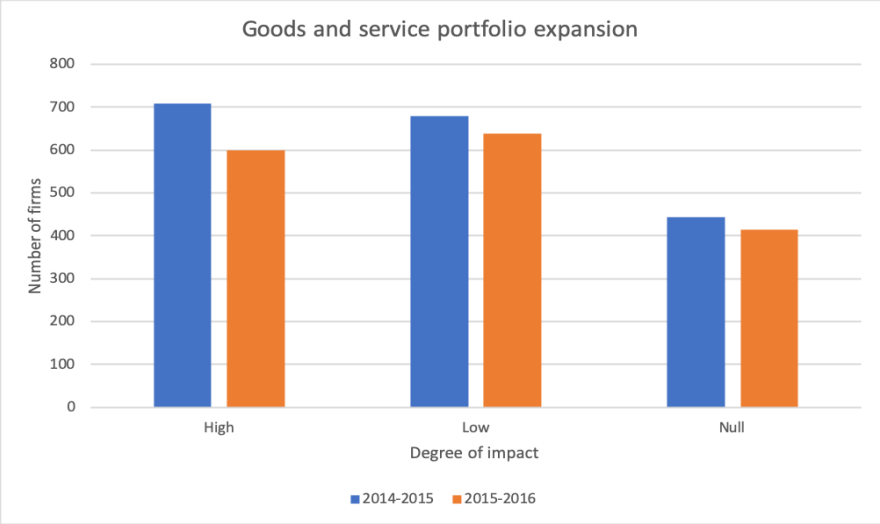
The questionnaire establishes different types of improvement that innovation can help to, and it divides it in three major groups: product, market and process. For the first one, it provides this information:

Figure 15. *Improvement on quality of goods and services*



Source: Author elaboration based on EDITS results

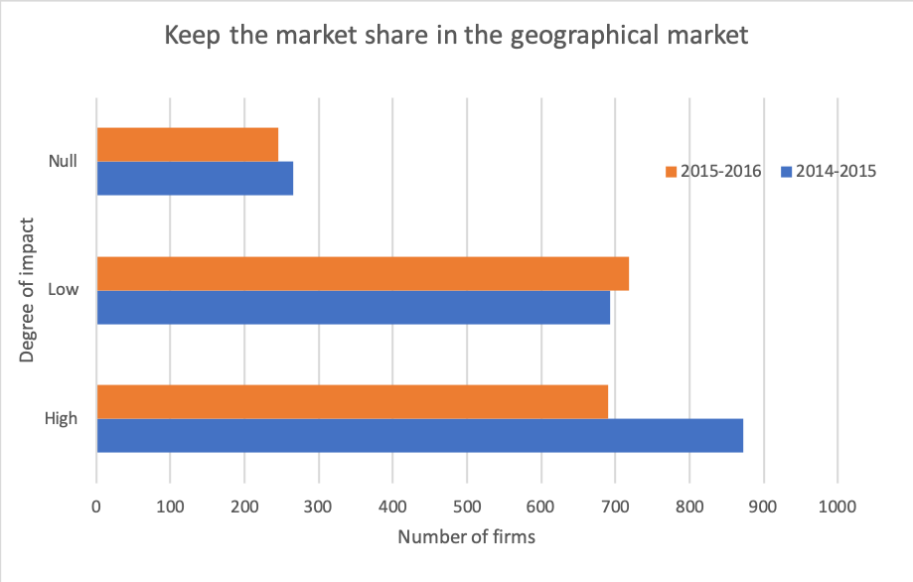
Figure 16. *Goods and services portfolio expansion*



Source: Author elaboration based on EDITS results

These graphs show the number of firms who said if the impact was high, low or nule. It can be observed that most firms agree that innovation has a high impact greater on the improvement of the quality of goods and services. Nevertheless, this perception reduced by 18% on 2016-2017 compared to 2014-2015. Also, the goods and services portfolio expansion have a high and low perception. In 2014-2015, more companies thought there was a high impact compared to a low impact. By contrast, for 2016-2017, companies thought low impact was higher compared to high impact.

Figure 17. *Maintain the market share in the geographical market of the firm*

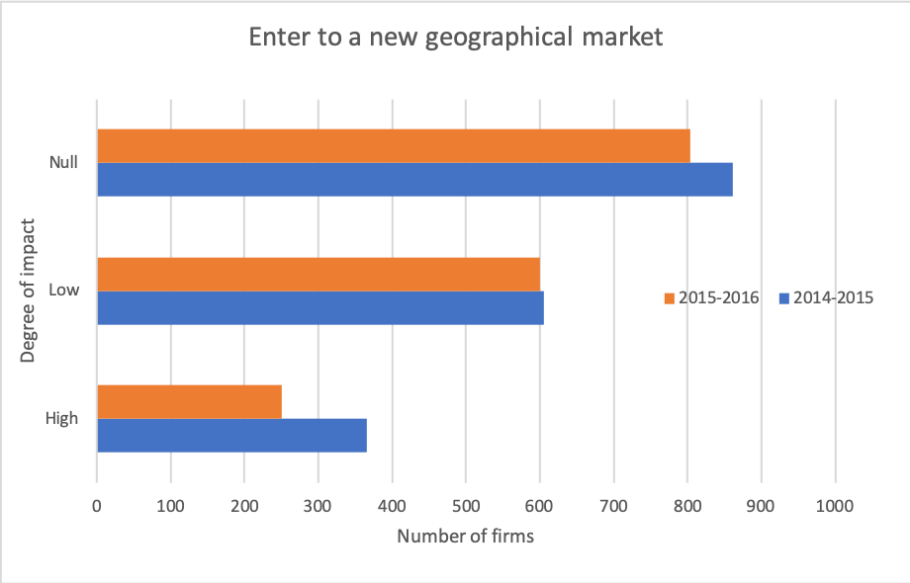


Source: Author elaboration based on EDITS results

In 2014-2015, firms thought innovation had a high impact maintaining the market share in the geographical market. Nevertheless, this perception decreased in 2016-2017 by 20,80% and in that year, they thought it was more the low impact than the high impact.

In the contrary, for the impact on innovation of entering to a new geographical market, the general perception is that its null. This means there is no direct relationship between the innovation and the geographical market expansion. This perception maintained in both periods of time. The firms that indicated there is a positive relationship were the 19,93% in 2014-2015 and the 15,12% for 2016-2017.

Figure 18. *Impact on entering to a new geographical market*



Source: Author elaboration based on EDITS results

The third group refers to the improvement in processes within the firm. They are the increase of productivity, the reduction of labor costs, the reduction in the materials used, reduction in energy consumption, reduction in water consumption, reduction in communication costs, reductions in transport costs, and reduction of maintenance and repairments costs.

Figure 19. *Impact on processes*

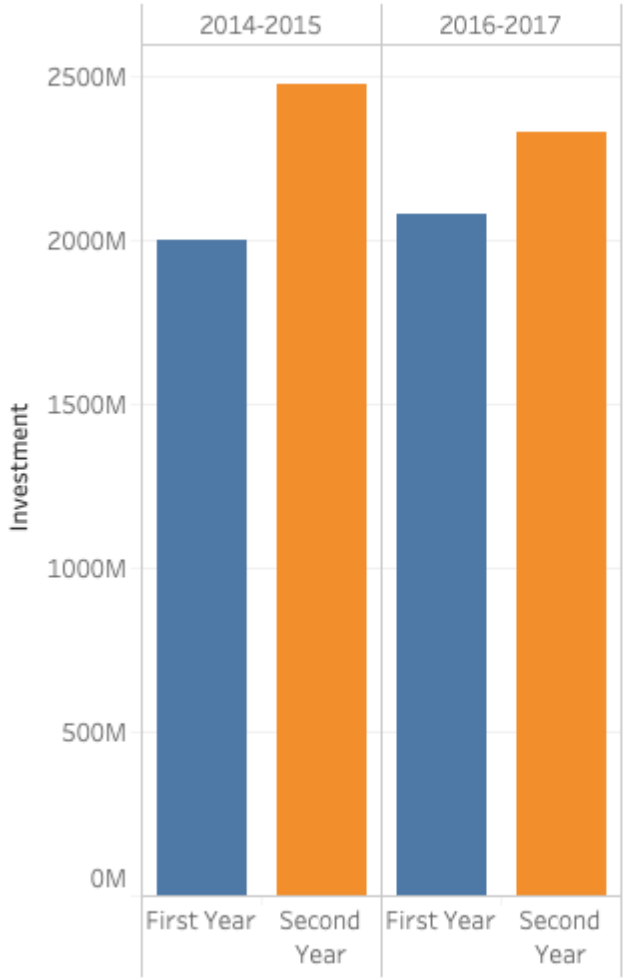
	2014-2015			2016-2017		
Impact	High	Low	Null	High	Low	Null
Increase of productivity	776	785	270	641	792	220
Reduction of labor costs	223	759	849	208	729	716
Reduction of materials used	170	610	1051	161	579	913
Reduction in energy consumption	177	528	1126	115	576	962
Reduction in water consumption	145	447	1239	91	468	1094
Reduction in communication costs	197	661	973	159	632	862
Reduction in transport costs	178	537	1116	137	528	988
Reduction in maintenance and repairments costs	181	631	1019	156	619	878

Source: Author elaboration based on EDITS results

The table above displays that there is no a great definition or tendency toward high or low in increase of productivity. In the contrary, there is a strong opinion that there is a low impact from innovation to reduction of labor costs. What attracts the most attention is that for the other impacts evaluated, the firms assure there is a null impact from innovation. This means that the data says there is no direct relationship between innovation and impact on the reduction of labor costs, reduction of materials used, reduction in energy consumption, reduction in communication costs, reduction in transport costs and reduction in maintenance and repairment costs. Comparing with the results of 2014-2015 with 2016-2017, no major changes are noticed as the perceptions remain the same.

4.3 R&D Investment and innovation

Figure 20. Investment for inovation



Source: Author elaboration based on EDITS results

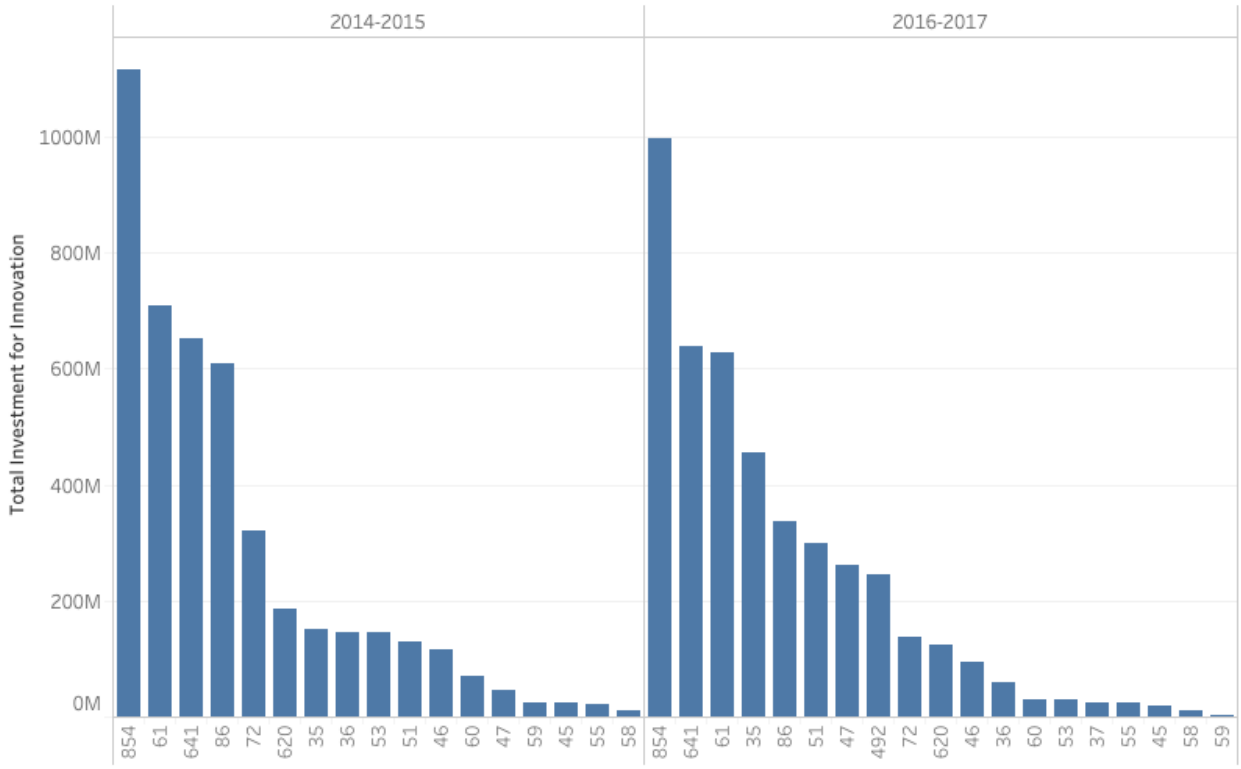
The graph above shows the first and second year for each period. This means that the first bar corresponds to 2014, the second bar to 2015, the third bar to 2016 and the fourth bar to 2017. It's evident that the second year of each period is where firms do more investment in R&D. Also, is notorious that the investment of the second year of each period (refers to 2015 and 2017) reduced along time.

Figure 21. *Investment per year*

	2014	2015	2016	2017
Average	$1.468.402	$1.166.033	$1.050.694	$1.176.706
Max	$61.609.826	$67.348.919	$97.406.220	$86.743.318
Min	$0	$0	$0	$0

Source: Author elaboration based on EDITS results

Figure 22. *Investment per sector*



Source: Author elaboration based on EDITS results

The service type 854 which corresponds to Higher Education was the service that had more investment for innovation. Compared on what already has analyzed, it can be established that there is a direct relationship between amount of investment and innovation. In other words, when investment grows, the probability that a firm does innovation is higher. Compared to 2014-2015, on 2016-2017 there was more investment by 641 than from 61, which was the opposite in the first

period.

There was significatively more investment in services Electricity, gas, steam and air conditioning supply (35), Air transport (51) and Retail (47). In the contrary, services such as Cinematography, sound recording and music editing (59), Human Health (86), Research and Development Centers (72), Development of computer systems and data processing (620), Water collection, treatment and distribution (36), Mail and courier services (53), and Wholesale (46) made less investment.

There are two examples that contradict that there is a direct link between innovation and the amount of investment for innovation. The first is 86, Human Health. It was previously stated that this service is a leader in the two time periods analyzed for significantly improved goods or services for the company and that when it comes to innovation within the company, Human Health leads. However, the total amount of investment decreased from 2014-2015.

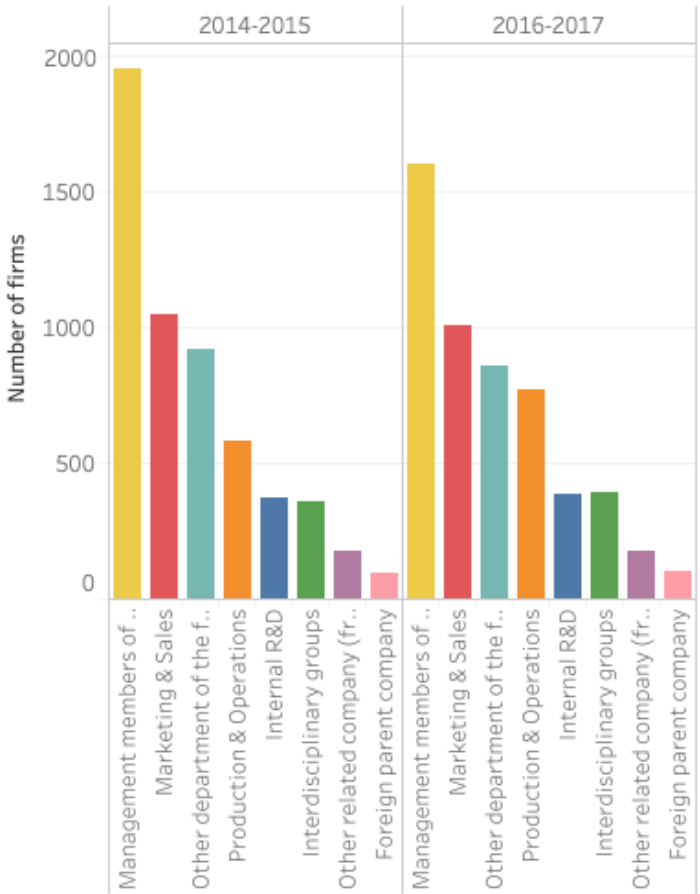
The second example is service type 72. This service also presents a reduction in total investment for innovation. However, the analysis said that for the international market, The R&D Centers were also leaders in totally new or significantly improved goods and services.

Therefore, for some services the data confirms that there is a direct relationship and other data also confirms that there is no relationship. Perhaps the first is due to a coincidence or that there are multiple factors in the environment, in addition to investment, that affect innovation.

4.4 Internal collaboration and innovation

The EDITS questionnaire includes the question if firms collaborate internally in order to improve innovation. They classify internal collaboration in internal department of R&D, department of production and operations, marketing and sales department, other department of the firm, specific interdisciplinary groups to innovate, management members of the firm, other related company (from the same group) and foreign parent company.

Figure 23. *Internal collaboration per year*



Source: Author elaboration based on EDITS results

The internal collaboration with the management members of the firm is the most important source on innovation. The second one, marketing & sales department represents the 53,60% of the first one for 2014-2015, and the 63,10% for 2016-2017. The order of the internal collaboration remains the same for the both periods analyzed.

The internal collaboration with the management members of the firm reduced on 17,97% in 2016-2017 compared to 2014-2015. On the other hand, internal collaboration using the production and operation area of the firm increased by 33,45%.

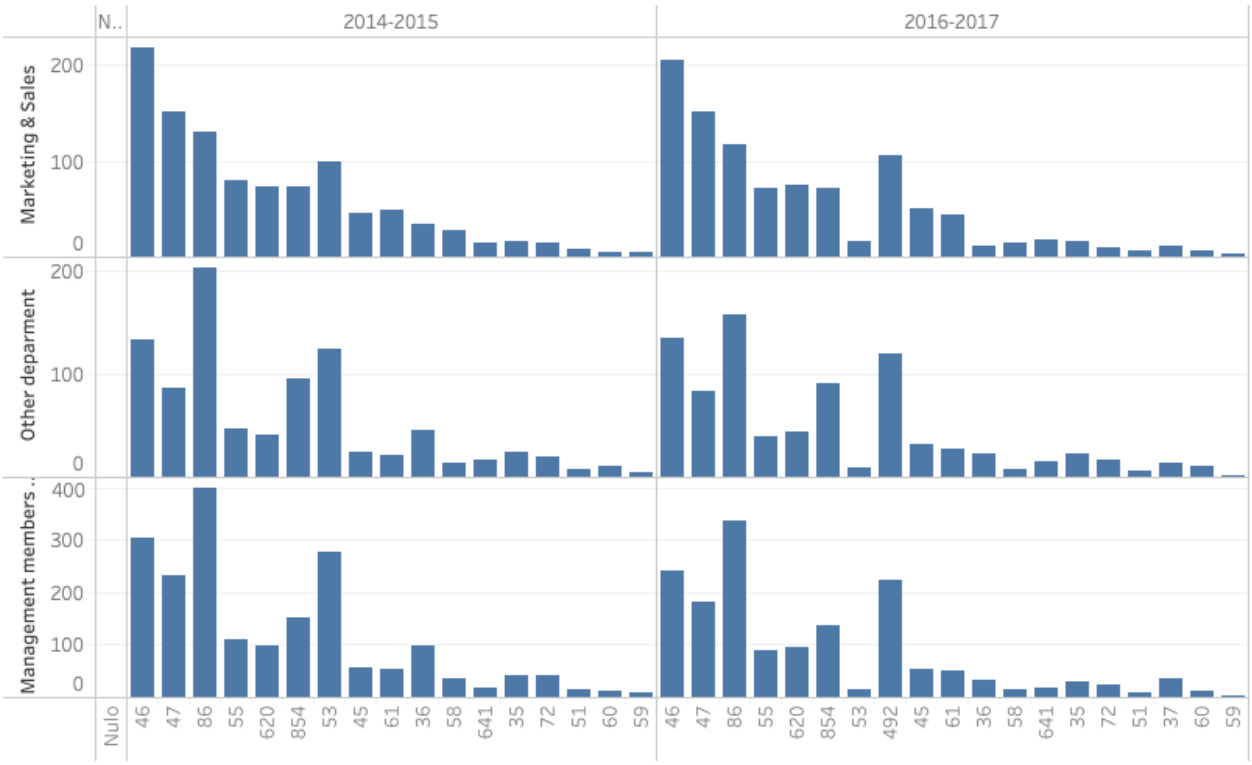
The internal collaboration with marketing & sales department, other departments, internal R&D department, interdisciplinary groups, other related companies from the same group and foreign parent company have remain the same, or the variation is very small that isn't relevant to the analysis.

It is considered now to continue the analysis of the most collaboration allies that are used by service type, and in the next graph is the same analysis with the less used.

As shown in Figure 24, the types of innovation that are more used are management members of the firm, marketing & sales department and other department of the firm. These three types of internal collaboration are displayed in the graph 19. It's evident that for Management members of the firm, the type of service that used it more was Human Health (86), Wholesale Trade (46) for 2015-2016 and 2017-2018 and also Public Automotive Land (492) for 2017-2018. These service types were rated as innovative above, so it's possible to conclude that there is a

positive direct relationship between internal collaboration and innovation.

Figure 24. *Internal collaboration by service type*



Source: Author elaboration based on EDITS results

Regarding other department of the firm, the firms that used this type of internal collaboration the most were Human Health (86), Wholesale Trade (46), Retail (47). Again, it's evident the repetitiveness of this types of services. Finally, considering marketing and sales department, the service type that collaborate with this partner the most was Wholesale trade (46), Retail (47), Human Health (86), and Transport public automotive land (492).

It seems important to note that the R&D department, whose role is on innovation and continued technological progress for the company, has no greater impact on the internal

collaboration for innovation. Is the fifth option preferred, but internal collaboration with marketing and sales and other departments of the firm are more used.

Also, there was a significant reduction of innovation for service dedicated to Mail and messaging services (53) for the three types of internal collaboration discussed above. For internal collaboration with marketing and sales, the reduction was of 84% in 2016-2017 compared to 2014-2015. For internal collaboration with other departments within the firm, it decreased in 92,74% and for internal collaboration with management members of the firm had a drop of 94,95%.

The services types that did no internal collaboration, at least in these three types, were Banking activities (641), Electricity, gas, steam and air conditioning (35), Research and Development Centers (72), Air transport (51), programming, transmission and diffusion (60) and Cinematography, sound recording and music editing (59).

4.5 External collaboration and innovation

The EDITS questionnaire studies the external collaboration and whether it is a national source or an international. It considers the following types of external collaboration:

Figure 25. *Types of external collaboration*

1	R&D department of another firm of the sector
2	Competitors
3	Customers
4	Suppliers
5	Firms of another sector

6	Associations
7	Chambers of Commerce
8	Technology Development Centers
9	Autonomous Research Centers
10	Incubators of technology-based companies
11	Technology parks
12	Regional Productivity Centers
13	Universities
14	Training centers
15	Expert consultants or researchers
16	Exhibitions
17	Seminars and conferences
18	Books, journals, catalogs
19	Industrial property information systems (patent bank)
20	Copyright Information System
21	Internet
22	Scientific and technological databases
23	Standards and technical regulations
24	Public entities

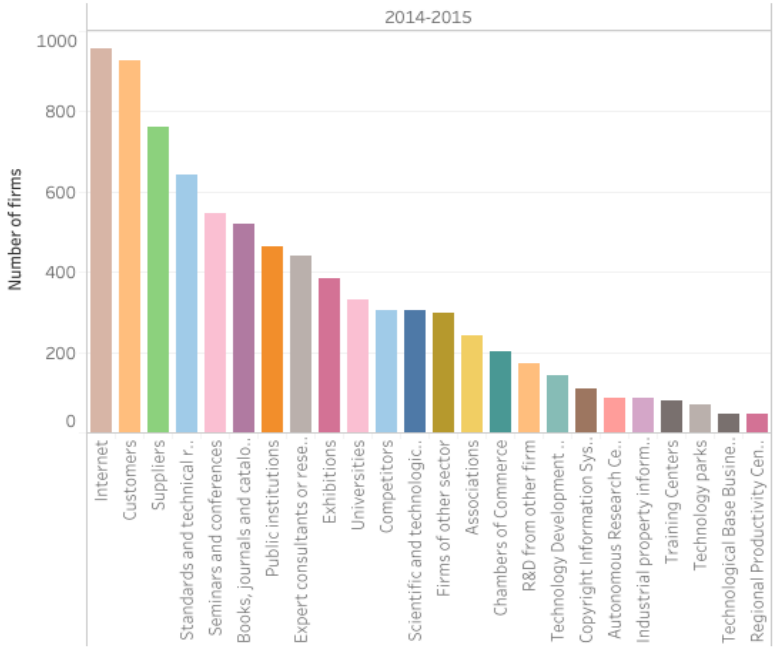
Source: Author elaboration based on EDITS results

Based on the following tables, it is feasible to conclude that in 2014-2015, internet, customers, and suppliers where the most common source of external collaboration. On the contrary, for the same period, the allies least preferred were Regional productivity centers, Incubators of technology-based companies, Technology parks, Training centers, Industrial property information systems (patent bank) and Autonomous Research Centers.

A valid observation is that in 2016-2017, internet, customers and suppliers keep leading

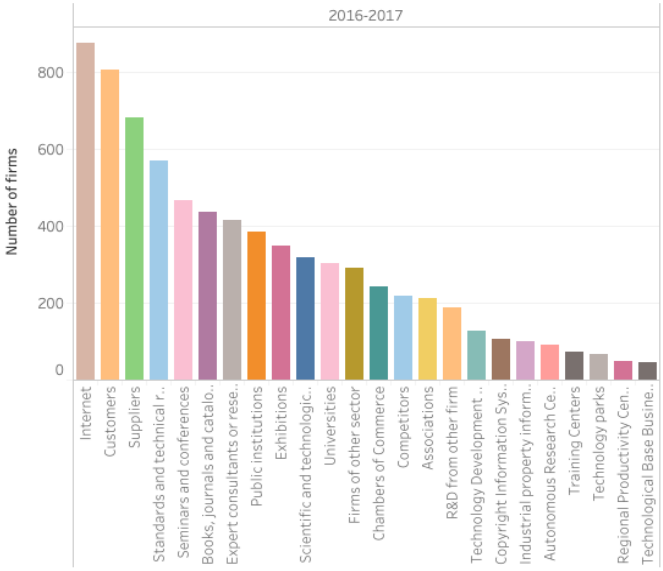
the external collaboration for services firms in Colombia, and there weren't major changes in the distribution.

Figure 26. *External collaboration for 2014-2015*



Source: Author elaboration based on EDITS results

Figure 27. *External collaboration for 2016-2017*



Source: Author elaboration based on EDITS results

Taking into account the allies more used for external collaboration for innovation, the following information is presented:

Figure 28. *External collaboration by service type*

Source: Author elaboration based on EDITS results

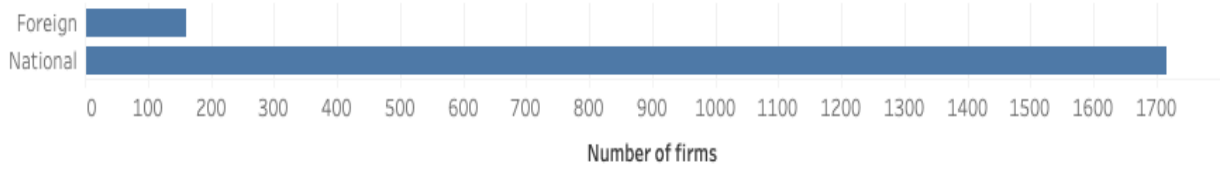
The other services types are excluded because the firms didn't use these types of external collaboration. In all cases, internet was the source more used by firms except by Retail (47), Mail and messaging services (53) and Development of computer systems and data processing (620).

The sectors that use the Internet the most are Human Health (86), and Wholesale (46). In contrast, the least used by the internet as an external source of collaboration are Telecommunications (61) and Supply of Electricity, Gas, Steam and Air Conditioning (35). This great use of the internet to collaborate externally confirms the theory that proximity is becoming less important, since by this means you can work collaboratively without having to be face to face.

One point to recall is that for Higher Education (854), universities are used by the same number of companies compared to the internet and customers. This has a great relationship with the social purpose of the type of service and that is why one might think that there is such a relationship between external collaboration and universities.

The other aspect that is important to analyze is whether the external partner for collaboration for innovation is national or foreign. For this part, they are considered again, the partners most preferred by the firms.

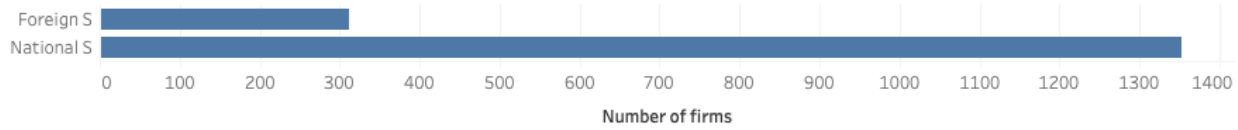
Figure 29. *National or foreign customers for collaboration*



Source: Author elaboration based on EDITS results

It can be observed that regarding external collaboration with customers, the firms select a national partner. The firms that select foreign ally are about the 13,70%. Of the total firms that do external collaboration for innovation (161 firms), the 14,90% of the firms are of Wholesale trade (46), 8.83% are of Accommodation and Food Services (55), 11.80% of Research and Development Centers (72), 22.33% of It Systems Development and Data Processing (620), and 11.80% of Higher education (854).

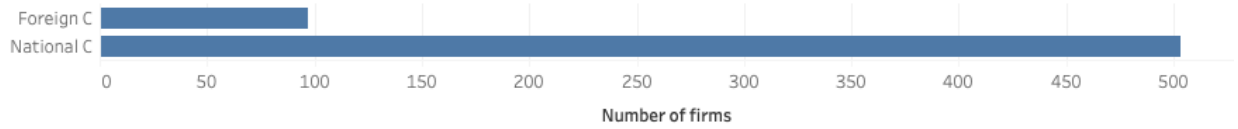
Figure 30. *National or foreign suppliers for collaboration*



Source: Author elaboration based on EDITS results

The same observation can be done here. The firms that used this type of external partner are less frequent than the external collaboration with customers and the source, in a major proportion, is national. Regarding foreign partners (312 firms), the types of services that used the most this type of collaboration are in 30,76% Wholesale trade (46), in 9.61% Development of computer systems and data processing (620), in 8.65% (854) and 8.01% in Telecommunications (61).

Figure 31. *National or foreign competitors for collaboration*



Source: Author elaboration based on EDITS results

The graph above represents the number of firms that used external collaboration with competitors classified by foreign competitor partner or national competitor partner. Is evident that the collaboration with national competitor is greater than foreign, as about the 20% of this number of firms have a commercial external collaboration relationship with a foreign partner.

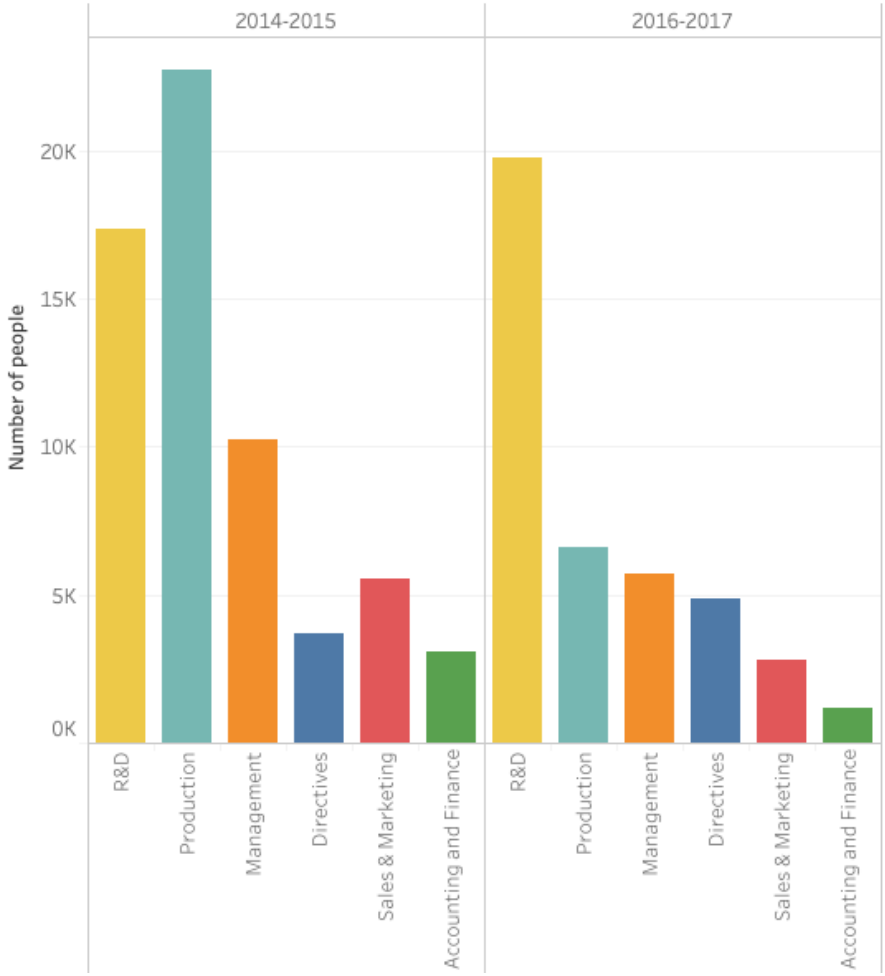
Regarding the external collaboration with foreign competitors, the services types that used it the most were 27,83% for (854), 14,43% for Comercio al por mayor (46), 10,30% for Development of computer systems and data processing (620), 9.27% for Banking Activities (641). The other types of services used foreign competitors' partners in less frequency, or it was never used.

4.6 Innovation Team

For EDITS, a group actively engaged in innovation activities may consist of the areas of general management, administration, marketing and sales, production, accounting and finance, and R&D as such, and the combination of this could will determine the success of innovation or not.

It is not possible to take out the correlation measure since the variable that measures the R&D team for innovation is measured in the number of people present in the team, and the innovation success is a binomial variable that is qualitative, because 1 means innovation and 2 no innovation.

Figure 32. *Innovation Team in 2014-2015 and 2016-2017*



Source: Author elaboration based on EDITS results

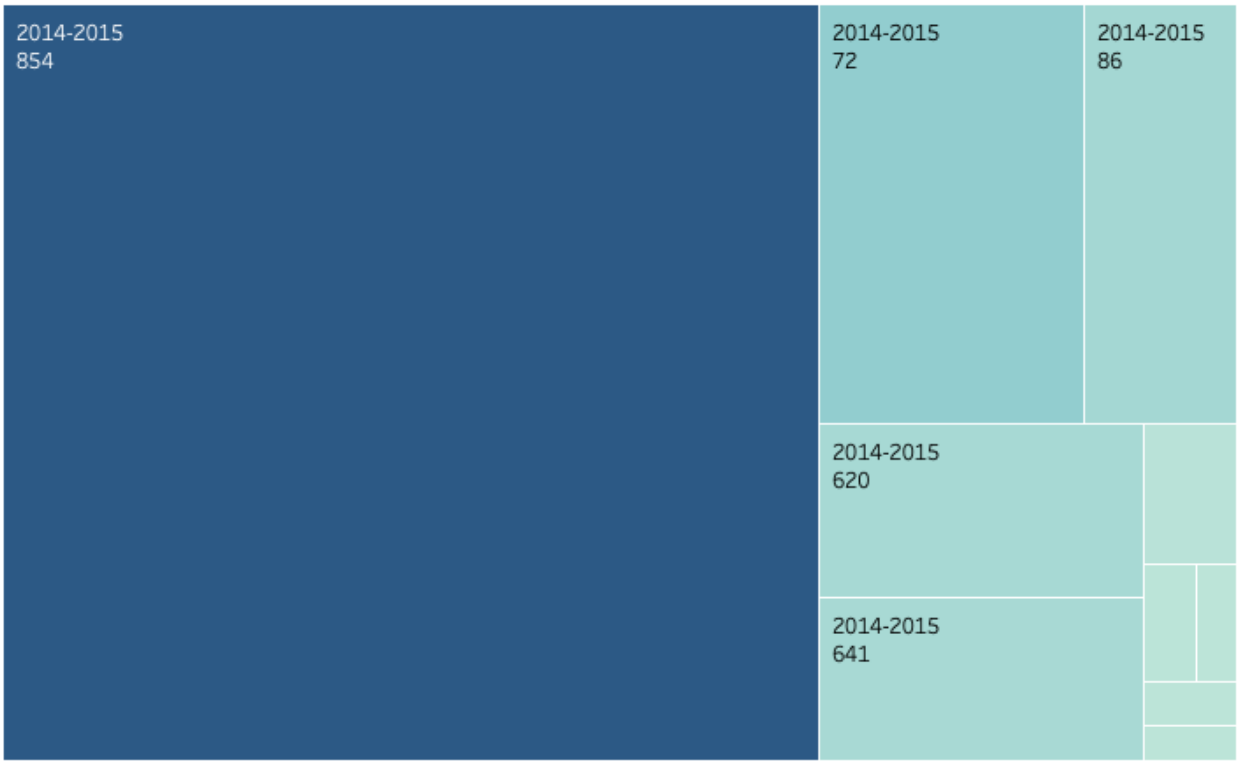
These results displayed are contradictory regarding the internal collaboration. For internal collaboration, the source more used was the management members of the firm which can be compared with directives, which for 2015-2014 was the least. Also, this source had a reduction in 2018-2017, but in the team distribution, the R&D resources increased 13,86%.

It is noteworthy that for the construction of the innovation team, they are mainly taken into account the department the R&D. Nevertheless, when talking about internal collaboration, this source wasn't the most important for the firms so it's possible to conclude that there is no direct

relationship between the team distribution with innovation, or specifically with the internal source of collaboration for innovation. This means that even if in the team most of the people are from one area, it doesn't mean that then the firm is collaborating internally with that area for innovative purposes.

Marketing and sales department was the one that contributed fewer people to the innovation teamwith a reduction of 48,99%, almost half of the team. In the other hand, the R&D personal of the team increased during time, from 17.384 persons to 19.794. For the contrary, production resources decreased radically in 70,81%.

Figure 33. R&D area for innovation team by sector, 2014-2015



Source: Author elaboration based on EDITS results

It's evident that from the group of R&D that corresponds to 17834 resources, the service type 854, which refers to Higher education, occupied the major number of people for the team for innovation (64,15%) by 2014-2015. This proportion increased in 2016-2017, passing to 72,94% of the total team. The types of services which also represent a significant percentage are Research and Development Centers (72) which is 11.56%, Development of computer systems and data processing (620) which is 5.87% and Banking activities (641) which is 5.53%.

In 2014-2015 the innovation team consisted mostly of production. Over time, the relationship changed, and the R&D area became more important. For both years, all types of service selected part of their production area to work on innovation by Cinematography, sound recording and music editing (59).

For Mail and Messaging Services (53) it was very important to always have part of the production area for innovation, leading this category. Of the number of people working for innovation from the production area, 38.07% belonged to this type of service for 2014-2015, and 22.65% for 2016-2017. It is then observed that there is a reduction of 82.64% of the total staff.

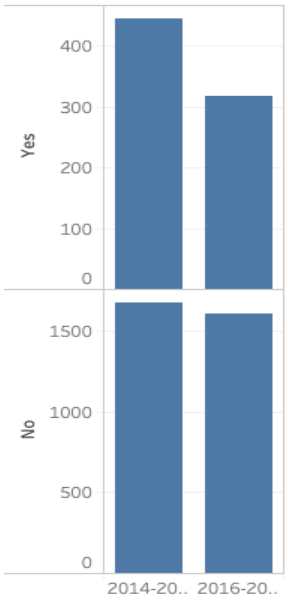
In contrast, companies from Electricity, gas, steam and air conditioning supply (35) increased in their innovation team the people in the production area, with an increase of 33.17%. The services that used the most to the production area for its innovation team in addition to the aforementioned were 19.97% for (86) and 13.40 for (854) in 2014-2015, and 22.64% & 17.83% for 2016-2017.

4.6.1 External Consultancy

There is a separate section which studies the "contraction of external consulting agents for the realization of scientific, technological and innovation activities" (DANE, 2017). The companies that responded that if they used this service for innovation activities were 444 in 2014-2015 and 318 in 2016-2017. On the other hand, the companies they said “no” were 1679 in 2014-2015 and 1628 for 2016-2017. This reduction of "no" isn’t significant, so it’s possible to think that the same level was maintained in both periods of time.

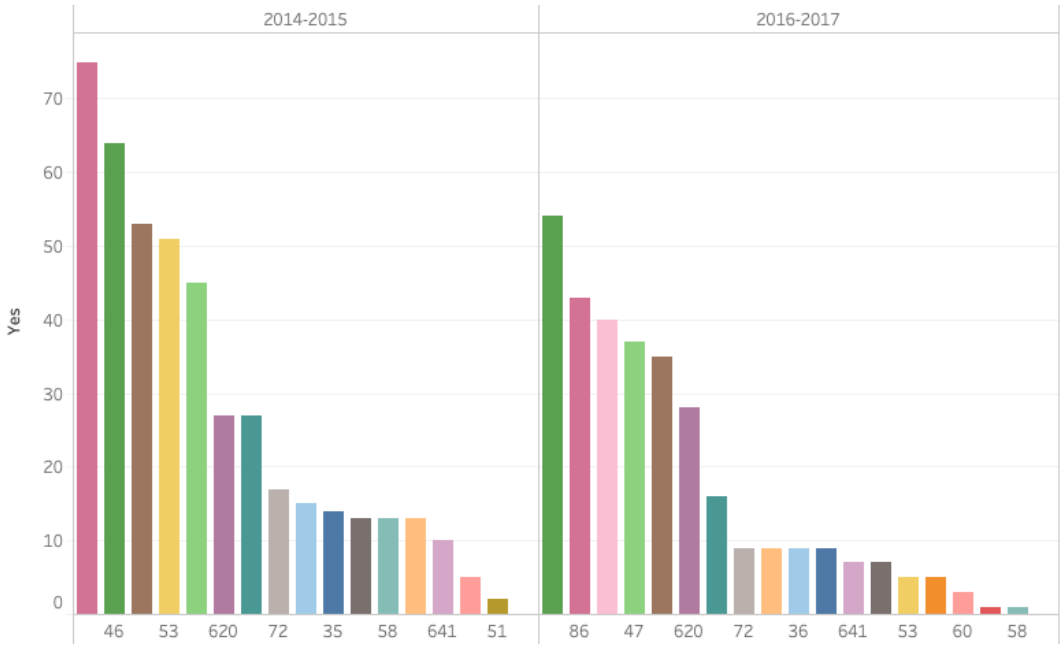
The companies that were taken into account for this question did not answer in their entirety given that the sample is 16707 companies, so this answer is not very significant.

Figure 34. *External consultancy service*



Source: Author elaboration based on EDITS results

Figure 35. *External consultancy services by service type*



Source: Author elaboration based on EDITS results

For 2014-2015, the service type that most used external consultancy was Human Health (86) and for 2016-2015 was Wholesale (46). There were no major changes in distribution over time, which changed was the number of companies taking the external consulting service but not the distribution of percentages per service.

The service type Mail and messaging services (53) had a radically reduction of consultancy services of 90.20%. This type of service had a decline in innovation that has already been discussed above, so it could be positively related to the use of external consulting with the success of innovation processes and activities.

4.7 Logistic Regression

For this statistical analysis it was necessary to reduce the sample because we found missing data. This means that some firms didn't answer the questions that were used. Therefore, the sample is now of 4051 firms. This is because in the question about internal collaboration has missing data.

The purpose of the model is to determine the likelihood of a company making innovation determined by the following factors:

- $a = internal\ collaboration$
- $b = external\ collaboration$
- $c = external\ consultancy$
- $d = period\ of\ time$
- $f = amount\ of\ investment\ for\ R\&D$

At least 86% of the companies that belong to the information base make some kind of innovation.

First, it is necessary to set the significance level of each of those variables set in the model. The following hypotheses are identified

- H_{0a}: Internal collaboration is not statistically significant for the model.$\beta_a = 0$
- H_{1a}: Internal collaboration is statistically significant for the model$\beta_a \neq 0$

- H_{0b}: External collaboration is not statistically significant for the model.$\beta_b = 0$
- H_{1b}: External collaboration is statistically significant for the model$\beta_b \neq 0$

- H_{0c}: External consulting is not statistically significant for the model. $\beta_c = 0$
- H_{1c}: External consulting is statistically significant for the model$\beta_c \neq 0$

- H_{0d}: The time period is not statistically significant for the model. $\beta_d = 0$
- H_{1d}: The period is statistically significant for the model$\beta_d \neq 0$
-

- H_{0f}: The amount of investment is not statistically significant for the model.$\beta_e = 0$
- H_{1f}: The amount of investment is statistically significant for the model$\beta_e \neq 0$

The R Studio tool provides the following information:

Figure 36. *Information R Studio*

	Estimate	Std Error	z value	Pr ($>|z|$) (P value)
(Intercept)	1.554e+00	2.289e-01	3.510	0.000449
Internal collaboration	4.000e-02	3.165e-01	0.126	0.899430
External collaboration	6.116e-01	9.505e-02	6.435	1.23e-10
Amount of investment	4.668e-07	9.119e-08	5.119	3.08e-07
External	3.123e-01	1.354e-01	2.307	0.021041

consultancy				
Period of time	3.855e-02	9.226e-02	0.418	0.676075

Source: R Studio information based on EDITS results

The alpha value is $\alpha = 0.05$. If the p value is smaller than the alpha, the null hypothesis H_0 is rejected. This means that only the intercept, the external collaboration, the amount of investment and the external consultancy are significant to the logistic regression model. This means that the model doesn't considers the internal collaboration and the period of time, as they are not significant or relevant for the model.

Second, Akaike's information criterion is applied. This works as a second filter and determines which variables are actually meaningful to the model. The tool provides the following information.

Figure 37. *R Studio information (part 2)*

```
                    Df Deviance    AIC
<none>                   3141.0 3149.0
- equipo_trabajo  1     3146.6 3152.6
- apoyo_externo   1     3182.0 3188.0
- inversion       1     3209.3 3215.3


Coefficients:
    (Intercept)   apoyo_externo1        inversion  equipo_trabajo1
      1.214e+00        6.093e-01        4.652e-07        3.102e-01
```

Source: R Studio information based on EDITS results

This means that the values of external consulting, external collaboration and the amount of investment for innovation are important to the model.

Taking into account the above, the likelihood of a company making innovation taking into account the variablesde $b = external\ collaboration$, $c = external\ consultancy$ y $f = amount\ of\ investment\ for\ R\&D$, is defined by:

$$\ln\left(\frac{\pi_i}{j-\pi_i}\right) = 1.214 + (6.093 * 10^{-1})b + (4.652 * 10^{-7})f + (3.102 * 10^{-1})c$$

It's important to notice that the variable $f = amount\ of\ investment\ for\ R\&D$ is quantitative, but the variables $b = external\ collaboration$ and , $c = external\ consultancy$ are qualitative. Therefore, the conclusions made are different for each type of variable.

- Amount of investment for R&D

There is supposed to be a company with external collaboration and external consulting. For every one (1) millions of Colombian pesos for investment, the likelihood of that company making some kind of innovation increases in:

$$\left(e^{1000(4.652*10^{-7})} - 1\right) * 100\% = 0.047\%$$

- External collaboration

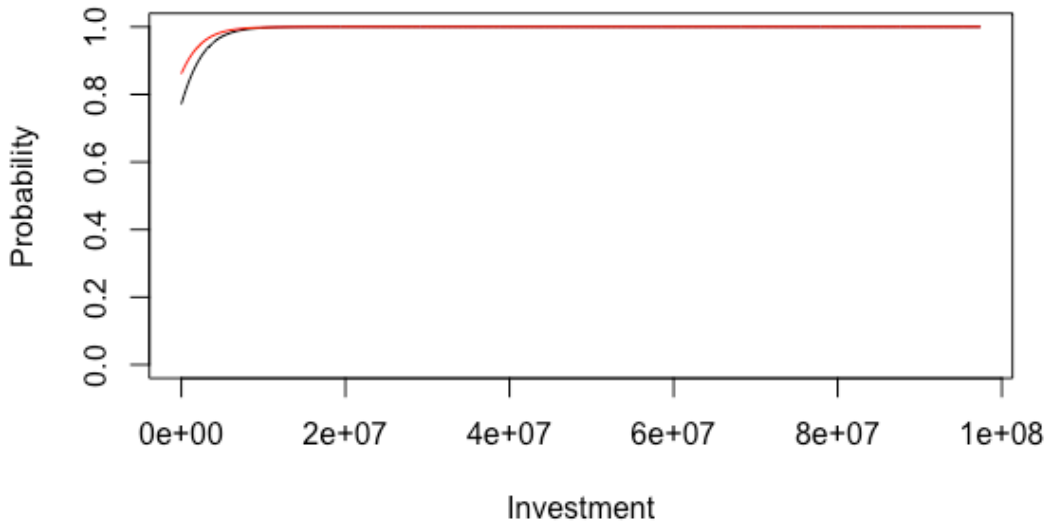
It is assumed that you have 2 companies both with the same investment and both with or without external consulting support. The first has external collaboration and the second does not, so the

probability of the first company making innovation is:

$$\left(e^{6.093*10^{-1}}\right) = 1.839$$

Times or 83.9% higher than the second company that has no external collaboration.

Figure 38. *Probability of innovation with external collaboration*



Source: R Studio information based on EDITS results

The more investment, the company is more likely to make innovation if it has external collaboration than if it does not do this kind of collaboration. The red line represents the companies that decide to have external collaboration and the black line represents the ones that do not. While both companies will be able to make innovation, the one with external collaboration will have a faster successful delivery.

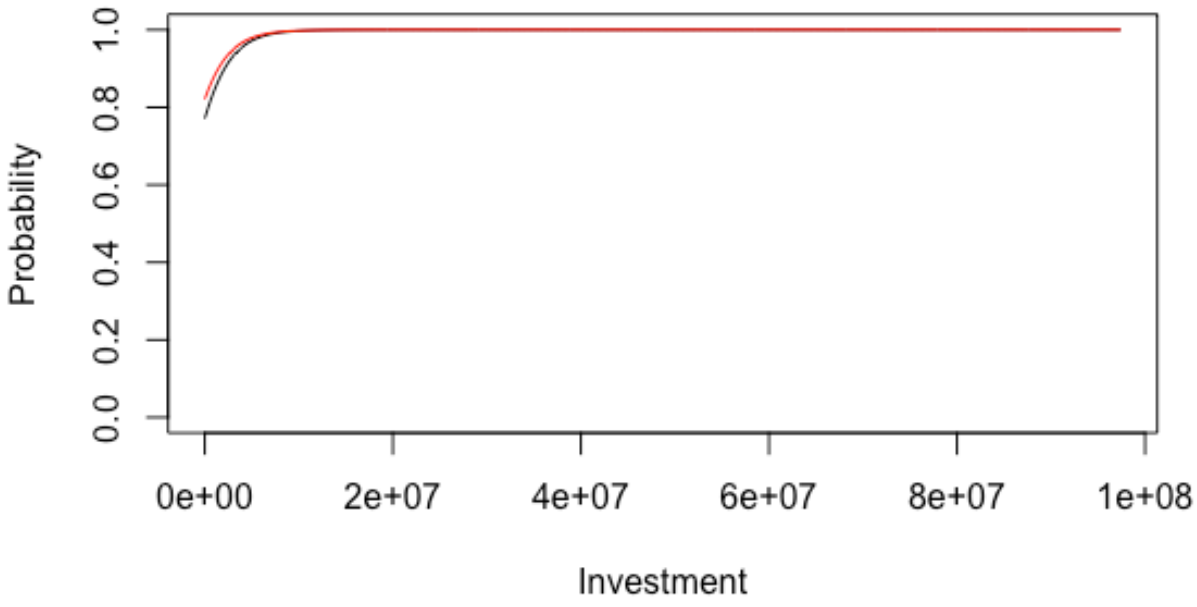
- External consulting

It is assumed that you have two companies both with the same investment and both with external collaboration. However, the first company has support from an external consultancy and the second company does not. So, the probability of the first company doing innovation is:

$$\left(e^{3.102*10^{-1})}\right) = 1.36$$

times o 36% higher than the second company that has no external consulting.

Figure 39. *Probability of innovation with external consultancy*



Source: R Studio information based on EDITS results

The graph above shows that the more investment, the likelihood of a company making

innovation with external consulting is higher than if it doesn't have one. The red line represents the presence of external consulting and the black line without external collaboration. While both companies will do innovation, the one with external consulting will do it faster.

- Cutting point

If a company has no external support, invests in R&D, or has external consulting, the likelihood of it doing some kind of innovation is

$$(e^{1.214}) = 3.36$$

Times the likelihood of not making innovation.

The logistic regression model determines the probability of a company making innovation taking into account the variables of external collaboration, external consulting and investment in R&D. The other variables are not statistically significant to the model.

It is therefore possible to conclude that, in order to make innovation, it is more important to have an external collaboration than a consultancy with an external company.

5. Conclusions and recommendations

The data confirms that innovation is an issue that is gaining strength as time goes on. The different ways of making innovation if they have variations and can be reduced, but in general Colombian companies are directing their efforts towards innovation.

The services that made the most innovation were Higher Education and Human Health in most cases. The above may be related to the number of companies that responded to the DANE survey were also of this type of services, so mathematically the percentage was going to be higher.

The budget for innovative activities has a great relationship with the success of innovation but it should be known that there are real examples in companies in Colombia that do not support this conclusion. In the face of internal collaboration, it was determined that the R&D department is not of great importance for innovation within the company, but that the attitude of towards innovation CEOs is vitally important and can determine the success or failure of the implementation of an innovation.

Collaboration with external sources is more common with the internet, customers and suppliers. The fact that the internet is used as a most recurrent source of external collaboration confirms the theory that proximity does not matter. The internet makes the world smaller and information can flow smoothly, and physical distance is no longer a problem for innovation.

The preferred partners for external collaboration are mostly national. Services such as those dedicated to banking do take precedence over collaborating with a foreign external partner.

However, when talking about the formation of the equipment for innovation, it is noteworthy that the greatest importance falls in the R&D area, and this proportion increases in 2016-2017 compared to the previous period 2014-2015.

With regard to logistic regression, it was determined that the most important factors for innovation are external collaboration for innovation, having an external consultancy and a budget aimed at innovation activities. These variables determine an equation that explains the likelihood of a company making innovation.

The logistic regression model determines the probability of a company making innovation taking into account the variables of external collaboration, external consulting and investment in R&D. The other variables are not statistically significant to the model.

It is therefore possible to conclude that, in order to make innovation, it is more important to have an external collaboration than a consultancy with an external company.

6. Limitations

It is to be known that the studio was done only with the service companies of Colombia. It would broaden the approach of making a comparison of the same of companies in different countries or the inclusion of different companies such as manufacturing in this same study.

In addition, all variables taken into account within the questionnaire were not included in the analysis. Patent-related information, ways in which companies finance innovation, intellectual property registrations, quality certifications, the training that exists for each person who supports the R&D team and their birthplace are variables that could be included to further fuel this analysis.

Also, the study was not a description over time, as there were only two time periods with the same inclusion periods. For further research, a unification of the formats could be done by obtaining the information from the previous questionnaires to obtain more timely information.

Including wastewater treatment and waste disposal services (37) and Transport public automotive land (492) is a bias because during period 2014-2015, there are no companies of this type of service.

In addition, it would also be Good to explore in depth what are the context of each service in order to understand the causes and consequences of variation in the different types of innovation.

For logistic regression, only certain variables that were relevant in the study could be taken into account. For further research, it would be good to find other variables that are significant and that can make the logistic regression model more accurate.

It would be important to complete this study or similar studies, that the questions asked in the questionnaire are all mandatory to answer.

7. References

Arguelles, E & Villavicencio, D. (2018). Un acercamiento al concepto de la innovación en los servicios públicos. *Entreciencias: Diálogos en la Sociedad del Conocimiento*, 8(18). DOI: 10.22201/enesl.20078064e.2018.18.64794

Beugelsdijk, S. & Cornet, S. (2002). A Far Friend is Worth More than a Good Neighbour: Proximity and Innovation in a Small Country. Journal of Management and Governance, 6(1), 169-188.

Chu, C. and Cheng, H. (2005). Business model innovation based on collaborative product development: a case study of taiwan design services. International Journal of Electronic Business Management, 3(4), pp. 257-269.

Cotic, A. & Prodan, I. (2008). How Internal and External Sources of Knowledge Contribute to Firms' Innovation Performance. Managing Global Transitions, 6(3), 277-299.

DANE. (2015). Technical Deveopment and Innovatio in Trade and Services Sectors – EDITS. DANE. Recovered from https://www.dane.gov.co/files/investigaciones/fichas/Technical_development_and_innov

ation_in_trade_and_services_sectors_EDITS.pdf

DANE. (2017). Cuestionario Encuesta de Desarrollo e Innovación Tecnológica en los sectores Servicios y Comercio – EDITS. DANE. Recovered from http://microdatos.dane.gov.co/index.php/catalog/584/related_materials

DANE. (2019a). Encuesta de desarrollo e innovación tecnológica (EDIT). DANE. Recovered from https://www.dane.gov.co/index.php/estadisticas-por-tema/tecnologia-e-innovacion/encuesta-de-desarrollo-e-innovacion-tecnologica-edit

DANE. (2019b). Generalidades. DANE. Recovered from https://www.dane.gov.co/index.php/acerca-del-dane/informacion-institucional/generalidades

De Liso, N. & Serena, A. (2017). The different approaches to the study of innovation in services in Europe and the USA. Metroeconomica. 68(1), 121-146. DOI: 10.1111/meca.12129

Doloreux, D., Shearmur, R & Rodriguez, M. (2018). Internal R&D and external information in knowledge-intensive business service innovation: complements, substitutes or independent? Technological and Economic Development of Economy, 24(6), 2255-2276. DOI: 10.3846/tede.2018.5694

Ebrahim, N. (2015). Virtual R&D Teams: a new model for product development. International Journal of Innovation, 2(3), pp.01-27. DOI: 10.5585/iji.v3i2.43

Ferre, M. (2019). FEIR 45: Regresión logística. DOI:10.5281/zenodo.2628915 Recovered from http://gauss.inf.um.es/feir/45/#28_resumen_de_c%C3%B3digo_en_r

Foronda, C. (2018). Characteristics and effects on innovation in Bolivian firms: an application of the CDM Model. Investigación & Desarrollo, 2(57), 57-72. ISNN 2518-4431

Herzlinger, R. (2006). Why Innovation in Halth Is So Hard. Harvard business review, 84(156), 58-66

Jiménez, A., Cabarcas, M. & Hernández, H. (2016). Innovation in health care institutions: a management strategy. INGENIARE, 22(1), 20-35

Kruse, P. (2012). The Role of External Knowledge in Open Innovation – A Systematic Review of Literature. Recovered from https://www.researchgate.net/publication/230578320_The_Role_of_External_Knowledge_in_Open_Innovation_-_A_Systematic_Review_of_Literature

Lee, S. and Shin, J. (2017). A Path to Collaborative Innovation Through Internal Boundary Breaking. Industrial Research Institute. pp. 26-32. DOI: 10.1080/08956308.2017.1325688

Li, Xiuquin., Gagliardi, D., & Miles, I. (2019). Innovation in R&D service firms: evidence from the UK. Technology Analysis & Strategic Management. 31(6), 732-748. DOI: 10.1080/09537325.2018.1549729

Lloyd, S., Low, S., Fitzgerald, G., Cliff, C. and Collie, J. (2018). View of The Ingredients for Innovation: impacts for practice and the education of health service managers. Asia Pacific Journal of Health Management, 3(2). DOI: 10.24083/apjhm.2018.0015

Martovoy, A., Mention, A. & Torkkeli, M. (2015). Inbound Open Innovation in Financial Services. Journal of Technology Management & Innovation, 10(1), 117-131.

Minguela - Rata, B., Fernández Menéndez, J., Fossas Olalla, M. and López Sánchez, J. (2014). Colaboración tecnológica con proveedores en la innovación de productos: análisis de la industria manufacturera española. Innovar, vol. 24. pp.55-65.

Naranjo, C & Calderón, G. (2010). Research on innovation in Colombia and Mexico: An analysis from the spread in scientific journals. Revista Universidad Nacional. 77(162), p. 191-203

Ozsungur, F. (2019). The impact of ethical leadership on service innovation behavior. Asia Pacific Journal of Innovation and Entrepreneurship, 13(1), 73-88. DOI: 10.1108/APJIE-12-2018-0073

Portafolio. (2015). Empresas colombianas no invierten en innovación. Revista Portafolio. Recovered from https://www.portafolio.co/negocios/empresas/empresas-colombianas-invierten-innovacion-41050

Ramírez, M. & García, F. (2018). Co-creation and open innovation: Systemic literature review. Media Education Research Journal, 54(26), pp.9-18. DOI: 10.3916/C54-2018-01

Ramos, M. (n.d.) Módulo XI: Explicación de datos categóricos. Universidad de Jaén. Recovered from http://www4.ujaen.es/~mramos/Cursos/RMEDI/RMEDI_T11_ExplCateg.pdf

Rosell, D. and Lakemond, A. (2011). Collaborative innovation with suppliers: a conceptual model for characterising supplier contributions to NPD. The R&D Management Conference.

Rubalcaba, L. (2015). Service Innovation in Developing Economies: Policy Rationale and Framework. Routledge, 51(1), pp: 540-577. DOI: 10.1080/1540496X.2015.1026694

Sánchez, I., Juliao, J & Zuluaga, J. (2013). The relationship between external networks and innovator performance of SMEs in Colombia: an analysis of moderator role of industrial environment. Estudios Gerenciales, 29(1), pp. 339-349.

Sánchez, G. & González, N. (2007). Fuentes externas de innovación: un análisis de la cooperación con clients en Europa y España. Decisiones sobre el conocliento: metodología de la empresa de gestion. Recovered from https://dialnet.unirioja.es/descarga/articulo/2487690.pdf

Sawheney, M., Verona, G. and Prandelli, E. (2005). Collaborating to create: the internet as a platform for customer engagement in product innovation. Journal of Interactive Marketing,

19(4), 4-17. DOI: 10-1002/DIR.20046

Scuch, G., Reisener, M., Mattern, C., Linnartz, M. & Basse, F. (2018). Evaluating collaboration productivity in interdisciplinary product development. Procedia CIRP 70. pp.211-216. DOI: 10.1016/J.PROCIR.2018.02.024

Strickland, J. (2010). Competition and Collaboration are not mutually exclusive. Lean Construction Journal. pp 76-85

Swink, M. (2006). Building Collaborative Innovation Capability. Research-Technology Management, 49(2). pp. 37-47. DOI: 10.1080/08956308.2006.11657367

Timenes Laugen, B. and Heidemann Lassen, A. (2012). Collaborative Innovation: Internal and External Involvement in New Product Development. IFIP Advances in Information and Communication Technology. Aalborg, pp.458-469. DOI: 10.1007/978-3-642-33980-6_50

WIPO. (2018). Índice Mundial de Innovación 2018: China se coloca entre los 20 países principales; Suiza, los Países Bajos, Suecia, el Reino Unido, Singapur y los Estados Unidos de América encabezan la clasificación anual. WIPO. Recuperado de https://www.wipo.int/pressroom/es/articles/2018/article_0005.html

WIPO. (2018). Perfiles estadísticos de los países: Colombia. WIPO. Recuperado de https://www.wipo.int/ipstats/es/statistics/country_profile/profile.jsp?code=CO

Villa, L & Melo, J. (2015). Panorama actual de la innovación social en Colombia. Interamerican development bank. Recovered from https://publications.iadb.org/es/panorama-actual-de-la-innovacion-social-en-colombia

Zhang, X., Yang, Y. and Su, J. (2015). Risk Identification and Evaluation of Customer Collaboration in Product Development. Journal of Industrial Engineering and Management, 8(3), 28-942. DOI: 10.3926/jiem.1423

Zand, D., & Sorensen, R. (1975). Theory of Change and the Effective Use of Management Science. Administrative Science Quarterly, 20(4), 532-545. doi:10.2307/2392021