Barriers to innovating with the public sector in Colombia: service sector perspective

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Abstract

Barriers to innovate with the public sector in Colombia: service sector supplier's perspective

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Innovation is a necessity to develop, no longer an option. This study assess the barriers to innovate with the Colombian public sector through empirical methods, providing the unexplored perspective of the private sector, furthermore, it will study the determinants of the barriers, until finally suggest policy recommendations in an attempt to correct the determined barriers using the experiences of other countries.

In the first half of the investigation, this study conducts an extensive literature review of barriers to innovate with the private and the public sector, and dedicates a section to analyze the experiences of other countries on adopting demand-side innovation policies.

On the second half, the empirical section, this research uses the survey conducted yearly by the National Department of Statistics (EDITX), which focuses on the innovation of the services sector. Through a Multiple OLS Regression, this section tests the proposed barriers of innovation, e.g. demand of innovation, finance management, IPR management and risk management, result of the literature review, and conclude that the size of the enterprise, the level of R&D investment and receiving Public Investment are three significant determinants, in the presence of Information as a moderator variable.

Finally, to overcome the identified barriers, first, this study recommends to strengthen the innovation ecosystem in order to guarantee the free circulation of information among the agents. Second, Colombia should design public policies of innovation taking into account the size of enterprises, specially enhancing their R&D investment, this research suggest to explore the flexibility of Public Procurement of Innovation in order to achieve this recommendations.

Key words: Public Procurement of Innovation, Innovation Policies, Demand-side policies, innovation ecosystem, procurement.

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Chapter 1. Introduction

1.1 Background

"The more we talk down the State's role in the economy, the less able we are to up its game

and make it a relevant player"

Marianna Mazzucato. *The Entrepreneurial State, 2013*

The Colombian government has been taking measures regarding the implementation of demand side innovation policies, following the lead of developed countries and the recommendation of the Organization for Economic Co-operation and Development. However, there are many aspects to improve on its implementation in Colombia, and many lessons to learn from countries with experience in this aspect.

Demand-side policies such as Public Procurement of Innovation and Pre-procurement of Innovation are highly recognized to be effective in influencing market sectors in the economy (Edler & Georghiou, 2007; OECD, 2011; OECD, 2017). However, its implementation is challenging because of the lack of standardized methodologies to measure the impact. To contribute to the process of effectively implementing demand side policies in Colombia, this study will attempt to identify the barriers to innovating with the public sector in Colombia, from the perspective of the suppliers. This will be achieved by analyzing the Survey on Development and Technology Innovation (EDIT)[1] conducted on the services and commerce sector, by the National Department of Statistics of Colombia.

1.2 The Purpose of Research

This research aims to provide clarity regarding the barriers experienced by Colombian suppliers for innovating in the services and goods provided to the Colombian public sector. Although demand-

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[1] Follow this link for more information: https://www.dane.gov.co/index.php/estadisticas-por-tema/tecnologia-e-innovacion/encuesta-de-desarrollo-e-innovacion-tecnologica-edit

side policies of innovation have been conducted in Colombia since 2014, due to OECD recommendations (OECD, 2014), which started to be followed with more rigor science Colombia became a country member in 2020, an empirical evaluation of the barriers to innovation from the supplier's perspective is highly needed to redirect the policies and maximize the fruits of innovation, especially in the Services sector, the focus of this investigation. Therefore, this research will provide a useful assessment of leakages in the public policy for innovation in Colombia perceived from the supplier's perspective, concluding in policy recommendations and suggesting practices to better tackle the identified barriers.

Conducting this study in Colombia is important for two reasons; first, Colombia is one of the largest economies in the region, part of OECD community and epicenter of a large capital flow; however, it also holds one of the lowest private sector investment rates on R&D among member countries (OECD, 2022). This is the case for public investment rates on R&D in comparison with other member countries in this international organization.

The second reason that makes this study relevant in Colombia pertains to the growing GovTech ecosystem in the country; recognized many times by international organizations like CAF and OECD[2]. GovTech refers to a partnership between a innovator public sector and the innovation private sector (mainly focusing on technology based startups) to offer better services to citizens. This built-in capacity has been growing throughout the last decade in the country and opens several doors to explore in terms of policy making, such as the broad topic of this document; Public Procurement for Innovation. Exploring the dynamics in the partnership between the Colombian public and private sector can contribute to enhancing the impact of public policy for innovation.

Moreover, the Services sector in Colombia is the selected sector to study in this research due to its deep relationship with the GovTech ecosystem, its novelty applications, and the usefulness that it

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[2] A strong partnership between Public and Private sector in Colombia, focusing on technology based startups, have been receiving support from international organizations such as the Developing Bank of Latin-American: https://www.caf.com/en/currently/news/2020/09/caf-and-innpulsa-sign-partnership-to-promote-govtech-in-colombia-through-milab/

provides to the market in terms of efficiency improvement and many more appliances, making it interesting to analyze deeply.

The Services sector, which includes the ICT subsector, is strategic for the development of the country; in this sector lie the tools to achieve several goals at the public and private level. In the public sphere, an innovative ICT sector contributes to the digitalization of many services provided by the government, its organizational interconnection, and the communication of the state-citizen/citizen-state relationship. At the private level, an innovative ICT sector opens up the door for capital flows and adds value to industries.

1.3 Research objective

The main objective of this research is to determine the barriers to innovating with the Colombian public sector from the perspective of suppliers. Furthermore, this research will assess public procurement policies to enhance innovation in Colombia in light of empirical evidence and policy experiences of OECD countries.

1.4 Research questions

As the research objective can be clearly divided by two, this study will attempt to answer two main research questions.

RQ1. What are the barriers to innovating with the Colombian public sector from the service supplier's perspective?

The first part of this investigation is focused on assessing the barriers to innovating with the Colombian public sector. This assessment will be done by conducting a thorough literature review that allows the research to acquire a state of the art of barriers affecting innovation. Afterwards, by applying quantitative methods, this study will assess the determinants of these barriers for the Colombian case, including mediator variables. This study will arrive to a set of barriers pertinent for the Colombian

context that can ultimately provide a framework for policy recommendations.

RQ2. What measures and mechanisms should be applied to correct the perceived barriers?

On a more ambitious task, this research will look at the experiences of 3 countries that have conducted successful innovation policies throughout the last three decades, and the Colombian case in order to offer policy recommendations to overcome the barriers.

1.5 Significance of the study

This study finds its significance on the assessment of the innovation policy implemented in Colombia and the lack of inclusion of the private sector perspective on the redesign of innovation policies. Studying the private sector perspective might provide unveiled insights on the barriers to innovate, furthermore, studying the experience of other countries with much more history implementing innovation policies, might point at solutions to the experienced barriers.

1.6 Methodology

This study adopts a case study design to determine perceived barriers to innovate with public organizations from the Colombian service sector perspective, furthermore, this research will study the determinants of those barriers perceived exclusively for enterprises that provide services to the public sector with the moderator role of information, and finally this study will suggest solutions to overcome these barriers. The case study design allows us to design qualitative research that identifies the possible barriers, and link the findings with an extensive analysis of Colombian and other countries' experiences in order to fulfill this paper objectives.

The data for the quantitative analysis is obtained from the 2019-2018 National Survey of Development, Innovation and Technology[3], conducted by the National Department of Statistics of Colombia. For the data analysis, this study will explore 2 models, the first model will test the

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[3] Visit the microdata webpage of the National Department of Statistics of Colombia. https://microdatos.dane.gov.co/catalog/699/get_microdata

characteristics of public sector service providers as determinants of the perception of barriers to innovate through a generalized linear model. Finally, using the same statistical method, model 2 will test the moderator role of information between the characteristics of enterprises and the perception of barriers to innovate.

Chapter 2. Theoretical background and literature review

This chapter will provide a literature review about the role of the public sector on innovation, making clear the relationship between the public sector and enterprises, allowing innovation to take place. Furthermore, in the second section, this chapter will conduct a framework review of the barriers to innovating (demand of innovation, risk management, financial capabilities and IPR management).

2.1 Literature review of the role of public sector as innovation agent

2.1.1 Demand-side policy and public procurement

The underlying aim of this research will be demand-sided innovation policies, more specifically, public procurement policies. These policies are developed in the interaction between governmental and private agents, the public procurement cycle setup, including a considerable amount of governmental discretion, with a desirable effect on SMEs. As governments like Colombia begin the endeavor of implementing demand-side policies, the private sector perspective on the policies implemented can contribute to correct the approach of the policy.

According to Georghiou et al., (2014), public procurement as an instrument of innovation policy is a challenge for policy makers, because, as stated before, the commonly used instruments on innovation policies are supply-sided which typically pursued to solve deficiencies in capabilities or resources that sets a favorable scenario for firms to innovate.

The use of demand-side policies to stimulate innovation in the private sector has been studied for the last three decades, surviving changes of economic paradigms across these years. Stimulating innovation through public procurement has found a place in the European Union agenda (European Commission, Directorate-General for Research and Innovation, 2012) and the recommendations of Organization for Economic Cooperation and Development (OECD, 2010).

The logic behind demand-side policies is straightforward; according to Georghiou, "the public

sector can overcome market failures by enlarging the market for certain goods and services, thus ensuring critical mass to encourage R&D investment" (Georghiou et al., 2014). Meaning that enlarging the market from the demand side theoretically incentivizes enterprises to readjust their supply function. Furthermore, if this marginal demand is created with certain additional incentives, in the presence of adequate conditions, markets will respond with innovation.

Part of the pioneers introducing the topic of demand side policies are (Rothwell & Zegveld, 1981), they argued that it is highly important that the government formulate industrial policies for innovation, participating actively in the use of public resources and engaging with regulation reforms. The methodology of their study draws an economic model to evaluate industrial policies for innovation in developed countries such as the United States, Japan and the United Kingdom, focusing on regulations that allowed innovation and sometimes even required it. These early studies paved the road for academia to investigate the instruments available and possible effects governments get from applying this type of policies.

In the early 90's, Geroski, (1990) advocated for an active role of governments on industrial policies for innovation. He concluded that government procurement for innovation stimulates innovation much more than government subsidies on R&D sector. His research reviewed many cases of developed economies, building up two arguments against the efficiency of the government's transferences policy to boost innovation. First, the high cost of R&D funding for tax purposes causes shortcomings on the desired impact and a big struggle to measure it. Second, the government providing direct funding to R&D poses a big level of discretion from government officials. Finally, according to Geroski, (1990), there is a need for an active government role in the market, enlarging the demand through procurement, using strategies like aggregating the demand of public needs, among others.

2.1.2 Using Public Procurement to boost innovation

In the last section, it was mentioned the relevance of governmental discretion regarding demand-side policies. Public Procurement is a force that is naturally driven by the government agenda

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(Boland & Godsell, 2021), which holds the power to steer the wheel of the economy in strategic directions towards economic growth. Using Public Procurement to steer the wheel of certain sectors of the economy, enhancing innovation poses two beneficial outcomes if implemented properly. First, the targeted economic sector becomes innovative, dynamic and competitive; second, the public sector, being the first risk taker, will absorb all the benefits reaped by the purchased innovations.

Historically, the way states have been approaching innovation is through supply-side innovation policies that involve transferring resources to public and private R&D think tanks or giving tax benefits to enterprises when investing resources in R&D; this topic was discussed in the previous sections of the document. However, using public procurement involves a new approach, i.e. changing the role of the government in the market as one risk taker consumer.

According to Mazzucato (2013, 73) the role of the state is commonly limited to creating knowledge and investing resources in R&D organizations (public or private); however, it should move forward and mobilize resources that allow the created knowledge and innovation to be spread across the different sectors of the economy. What Mazzucatto suggests is a more active role of the state in the economy, intervening on the market and behaving as a facilitator of innovations to be tested, improved and standardized for the common good of the economy.

This active role of the state implies investing resources on strategic sectors using procurement needs. A clear example is the efforts made by the Defense Advanced Research Projects Agency (DAPRA), starting with the creation of the Internet by the end of last century. A close partnership between the public and private defense sector made possible not only the creation of the internet, but also its commercialization. (Block, 2008). Nowadays, the US government is reaping the fruits of the innovations created under the umbrella of DAPRA. Today, the efforts spanning beyond basic research funding are oriented to biotechnology and nanotechnology.

Moreover, in the last three decades Jakob Edler [4] has studied demand side policies for

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[4] Professor, Manchester Institute of Innovation Research, Alliance Manchester Business School, University of Manchester, UK

innovation in Europe, focusing on the impact areas of states when implementing this type of policies. His studies in collaboration with different authors are reflected in the book "*Handbook of Innovation Policy Impact*". Among many topics of research, Edler (Cunningham et al., 2016) focuses on the Public Procurement of Innovation as a key policy tool by the government to support strategic economic sectors and enhance innovation inside public organizations. These studies and several more inspired the inclusion of demand-side policies in OECD and EU strategies for its country members. This document will use Edler's research to frame the findings of statistical models and conduct several policy recommendations.

According to Edler & Georghiou (2007, 952) there are 4 dimensions that holds the highest significance on the successful implementation of procurement of innovation: first, coordination of government dependencies, second, active communication with the suppliers (private sector), third, signaling expectations and opportunities and forth, an aligned procurement chain. His methodology in this paper is based on a thorough review of different researches that implemented surveys and interviews to determine the main drivers of successfully innovating with the public sector of various European countries.

First, coordination of government dependencies is highly relevant. The newness of innovation in the public sector embodies a challenge for several dependencies due to a lack of expertise and uncoordinated objectives. Clarifying the responsibilities and ensuring the capabilities of the people in charge is highly important for implementing a successful procurement of innovation policy. In the mentioned research, (Edler & Georghiou, 2007, 952) poses the following question to evaluate this first dimension: "Are the ministries responsible for innovation coordinated in terms of demand for innovation and budget?"

Second, there should be active communication with suppliers to incentivize the private sector and provide valuable feedback in the procurement process; this can also encourage their participation in innovation tenders due to an alignment of expectations that comes from the dialogue between the two sectors.

Third, signaling is crucial to match expectations and opportunities of improvement of products, where innovation can take place. As both the demand and the supply collaborate, this brings public needs and supplier's capacity into line (Edler & Georghiou, 2007, 959). It is common to find a clear separation of tasks in the relationship of public and private sector when it comes to procurement of private services. Generally, the private sector restrains from stepping into a redesign of the services contracted, and the feedback is limited. In addition, the knowledge acquired from the relationship with the final consumer (most of the time, the citizens) is not commonly shared to the procurers to adjust the services contracted. Economic tensions and negative incentives to not collaborate are a natural reason for this behavior.

Fourth, according to Edler and Georghiou (2007)'s research, the alignment of the public procurement chain is also relevant to enable innovation. Aligning decision makers and minor level public officials involved into the procurement process of innovation, implies the diffusion of objectives, procedures and desired outcomes of the initiative. This misalignment is sometimes caused by a top-down rationale that finds major obstacles in communication and expertise within the involved actors: the legal consequences of a risk taker public tender and the discoordination of responsibilities are the major contributors to the mentioned misalignment. In the mentioned research, Edler & Georghiou, (2007, 96) pose a question to evaluate this fourth dimension of a successful implementation of the innovation policy: "Is there a logical chain of procurement on the desired impact and the product or service to procure?"

After reviewing the four dimensions of a successful implementation of procurement of innovation policy, it's important to highlight practical areas where the policy can be implemented. In the next paragraphs we will analyze the policy areas countries and scholars have implemented and designed public procurement of innovation (PPI).

2.2 Literature review of the barriers to innovate

There are several researches that frame the implementation and impact of innovation policies,

some of them are cited in the last section of the document. In this section, we will focus on the barriers to innovation, in an attempt to categorize them and build the foundations of empirical work. The majority of studies about the barriers to innovation overlap with various research about the determinants to invest in R&D. Many of these studies build upon the hypothesis of Schumpeter, (1961); through case studies, some authors add variables that apply to the context of each research. The table No. 4 summarizes the relevant studies analyzed in this section, dividing the barriers in 2 broad categories, internal and external factors to innovate.

Study reviewed	Scope of the article	
	Private	Public
(Suárez-González & Galende, 1998)	x	
(Varsakelis, 2000)	x	
(Uyarra et al., 2014)		x
(Corchuelo & Carvalho, 2013)	x	

Table 1. Relevant studies analyzed

2.2.1 Framework review

2.2.1.1 (Suárez-González & Galende, 1998) Determinant Factors of private investment in R&D

In their study, Suárez-González & Galende, (1998) built a framework for the determinants of enterprise investment in R&D, backed up with an extensive literature review; they categorize into two big groups the factors: external and internal, see Figure 3. The external factors are related to the market and the decisions of the "Administration" (referring to the public policies implemented by the states). In this group we can find the R&D intensity of the market section of the enterprise as a sector characteristic, and for the generic environment, we can find the innovation policies implemented by the state such as the protection of IPR, the incentives on R&D investment or the demand of innovation.

For the internal factors, much less studied in academia, we can find human resource capabilities of the enterprise, financial resource capacity and organizational capacity. According to Suárez-González & Galende, (1998, 69), the internal factors are highly important on determining the level of investment of the enterprise, defying the current academic approach about "The resource-based view of the firm" (Wernerfelt, 1984) on which it is believed that the external factors are the most determinant for private R&D investment.

Suárez-González & Galende (1998) proves the intensity of each classified factor to invest in R&D through a case study approach in Spain. They implemented a survey on a sample of 100 non-financial enterprises, finding that the most relevant factors which influence the decision of investment on R&D are the quality of human resources, the capability of financing with own resources, and belonging to a technology-intensive industry.
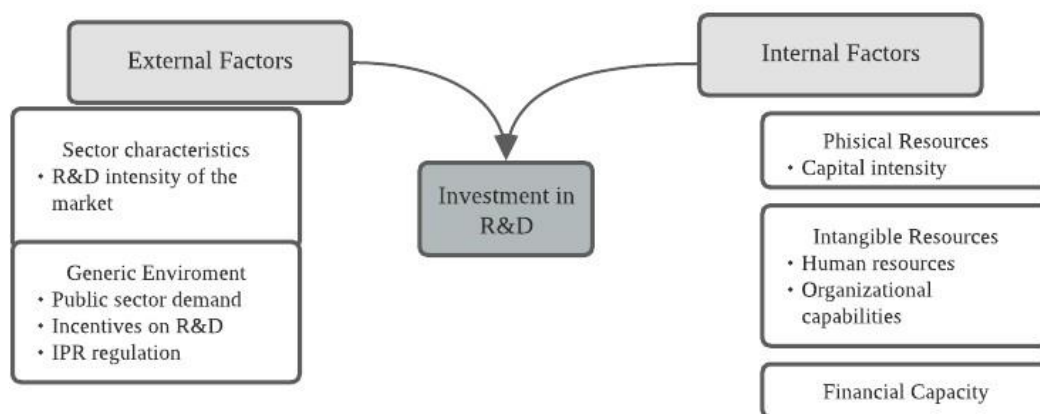
Figure 1. Determinant Factors of private investment in R&D. Adapted from (Suárez-González & Galende, 1998)

2.2.1.2 Varsakelis, (2000) The impact of patent protection, economy openness and national culture on R&D investment: a cross-country empirical investigation.

The study of Varsakelis (2000) has the purpose of clarifying the institutional factors influencing the private investment on R&D. Following the concept of Edquist & Johnson (2000) "institution" is defined as common practices or habits that determine the relationships between individuals on a specific

setup; they concentrate on examining the external factors of R&D investment. Furthermore, they consider three main variables: the national culture, the openness of the economy and the regulation on intellectual property rights. See the scheme shown in Figure 2.
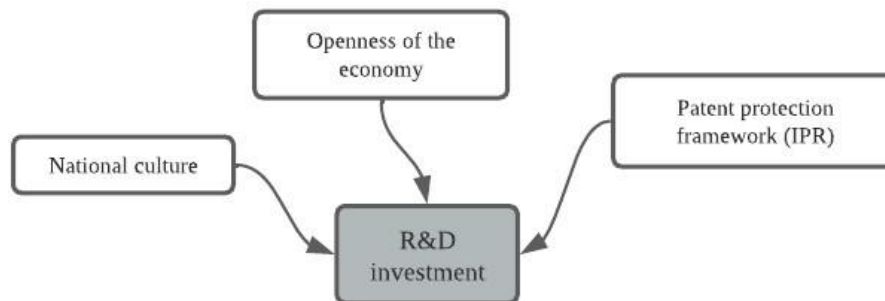
Figure 2 Impact of factors on R&D investment. Adapted from Varsakelis, (2000)

Here *National Culture,* as argued by Edquist & Johnson (2000), represents the capability of a society to innovate naturally. This variable is operationalized in this model by the Power Distance Index (PDI). The PDI refers to the degree of independence the subordinates have over the roles of leadership in every setup in the society, presumingly, allowing individuals exploring new possibilities, and taking bold decisions that can give birth to innovation.

Second, the variable *Openness of the Economy* represents the spillovers from international flows of knowledge into the local marker. For Edquist & Johnson (2000), the more open the economy is, the higher the marginal productivity of the stock of knowledge and therefore, the higher desire of new investment in R&D. This variable is operationalized as the rate of Black Market Premium (BMP), utilized in the study of Warner & Sachs, (1995). Finally, the *regulation about Intellectual Property Rights (IPR)* in the market is important in this equation because, according to Edquist & Johnson (2000), the momentary monopoly on the produced novelty, plays a high incentive for enterprises to invest in R&D, because during this period of time, they can exploit the advantage of their investment to its fullest. On the flipside, weak regulation on IPR can pose a barrier on R&D investment in the model.

This study tested the intensity of the mentioned variables and their influence on R&D

investment, using a cross-country analysis on 50 countries. Edquist & Johnson, (2000), concluded that a rigorous IPR management by authorities enables a highest R&D investment; moreover, the national culture of the country is correlated to the level of R&D investment.

2.2.1.3 Uyarra et al., (2014) Barriers to Innovate through public procurement: A supplier perspective.

The study of Uyarra et al., (2014), attempted to be as detailed as possible on the drivers of innovation and the barriers of the innovation policy which were experienced by the UK. The authors conduct an extensive literature review to classify the most significant barriers to innovate with the UK public sector. They categorized 7 barriers as follows: poor management risk, inadequate management Intellectual Property Rights (IPR), low procurer capabilities, lack of interaction with procuring organizations, contracts not long enough nor big enough, specifications too prescriptive and lack of demand for innovation.

At the same time, the authors found it relevant to evaluate the policy categories of Public Procurement of Innovation found in the procurement cycle (categorized by Georghiou et al., 2014). They classify them as follows: consistent procurement, large contracts participation, sufficient information tenders, and useful feedback. Unsolicited ideas, private sector delivery history and performance qualification conditions. These variables have the function of secondary variables affecting innovation. A summary of the conceptual model of this study is found in Figure 3.
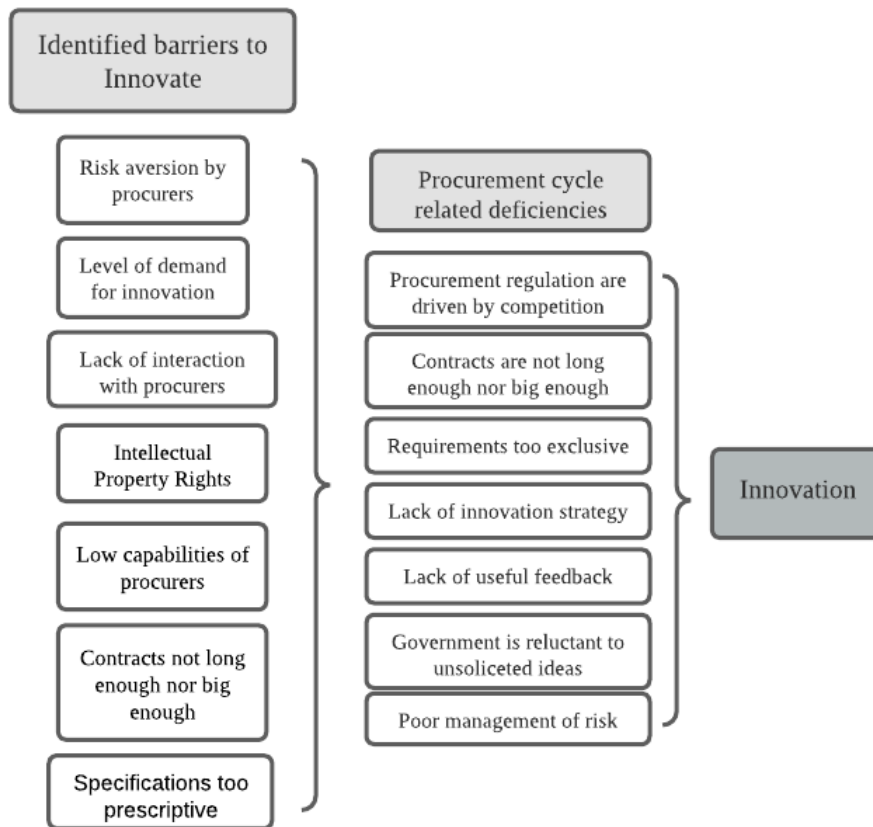
Figure 3. Barriers to innovate through public procurement. Adapted from (Uyarra et al., 2014)

To evaluate the intensity of the classified barriers, they collected the data using phone surveys, asking 800 UK enterprises that provided goods or services to the public sector to identify the experienced barriers on a list, then asking the enterprises to assess the procurer characteristics in relation with their policies incentivizing innovation on the enterprises. The enterprises were classified by their size and level of investment in R&D.

Finally, Uyarra et al., (2014) found out that the enterprises identified 4 main barriers to innovation: lack of interaction with procuring organizations, the use of rigid as opposed to outcome based specifications, low competency of procurers, and a poor management of risk., this study concluded that these barriers are perceived more intensely by R&D intensive enterprises.

2.2.1.4 Corchuelo & Carvalho (2013) Obstacles to innovation and public policies oriented to enhance innovation.

In this study, Corchuelo & Carvalho (2013) make a theoretical classification of the determinants to innovation on enterprises from Extremadura, Spain. They found three big groups to classify the determinants of innovation, shown in Figure 4; external, internal and cooperative. The external and internal aggrupation of factors of innovation are also used in other studies, such as the cited study of Suárez-González & Galende (1998).

The external factors to innovation refer to the demand of novelties in the market, the technological opportunities and the conditions of ownership of innovation. For the last factor, it is necessary to clarify that the ownership of innovation depends directly on the effective management of IPR by authorities, which allows the innovator company to naturally enjoy the fruits of their innovation.

For the internal factors, the author classifies the financial capabilities of the enterprise, the capital intensity, and the intangible resources; regarding the last factor, Corchuelo & Carvalho (2013) mentions the relevance of human capital and commercial resources as key enablers to innovation, according to the theoretical review. The last group of determinants for innovation is the cooperation within the market. The author calls this a big enabler of innovation which allows the reduction of risks and the flow of knowledge.
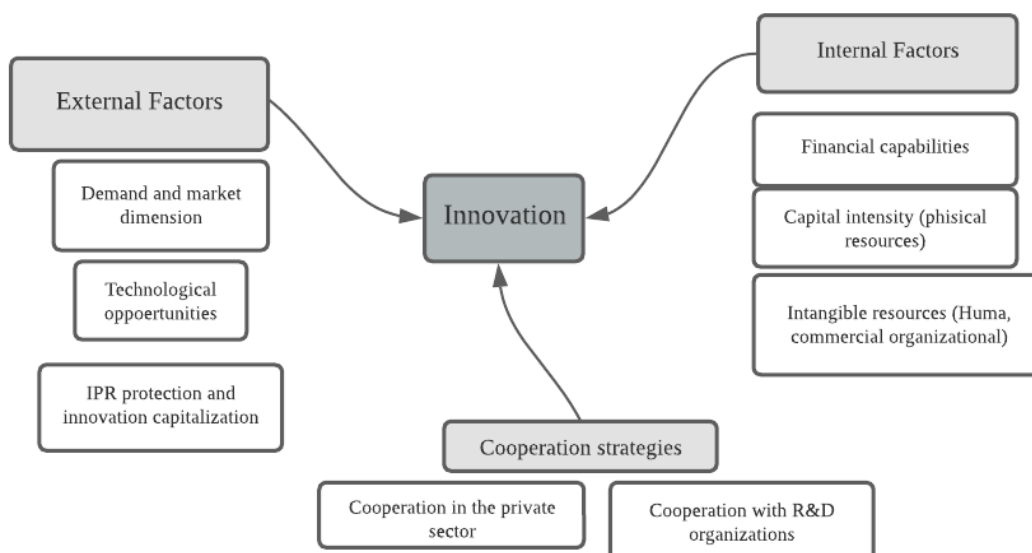
Figure 4. Determinant factors to innovation on enterprises. Adapted from (Corchuelo & Carvalho, 2013, 4)

Finally, this study tested the intensity of the classified determinants of innovation through a

dedicated survey. The analysis of the collected data with sample of 777 private enterprises in Extremadura, Spain, found that

2.2.2 Comparison of frameworks

The purpose of discussing the literature about barriers to innovation perceived by enterprises thoroughly is to create a baseline of the variables we will evaluate empirically in the following sections of this research. In Table 6, we present the comparison of the discussed studies; the table aggregates the comparison into 3 groups, frequently utilized in the studies; these categories are internal, external and cooperative.

Comparing the barriers to innovation, this study observed four common categories that influence innovation; *Demand of innovation, Risk management, IPR management, and Financing capacity.* These factors will be the foundation of the econometric model and will be discussed in the next section.

The decision to narrow down the factors to a total of four was made considering the relevance of each factor to the context of the ICT sector of Colombia and the impracticality of covering all the possible factors. Moreover, despite knowing that other less relevant factors are left aside in this study, we believe that this study covered the most important categories. We encourage other researchers to dig deep into the findings of this study and consider the possibility of including other excluded factors associated with the characteristics of the studied market.

Study reviewed	Internal	External	Cooperation
(Suárez-González & Galende, 1998)			
Demand		x	
IPR regulations		x	
Capital intensity	x		
Intangible resources (Human, organizational)	x		
Financial capacity	x		
Sectoral characteristics (R&D intensive)		x	
(Varsakelis, 2000)			

National culture		x	
Openness of the economy		x	
IPR regulation		x	
(Uyarra et al., 2014)			
Risk aversion (by procurers)		x	
Demand of innovation		x	
Lack of interactions	x	x	x
IPR regulation		x	
Low capabilities of procurers		x	
Tenders specification		x	
(Corchuelo & Carvalho, 2013)			
Financial capabilities	x		
Capital intensity	x		
Demand and market dimensions		x	
Technological opportunities		x	
Intangible resources (human, commercial)	x		
Cooperation within enterprises			x
Cooperation with R&D companies			x
IPR regulations		x	

Table 2. Comparison of frameworks.

2.2.3   Barriers to innovate

This research will use four dependent variables that constitute the most relevant factors identified as barriers by suppliers in the literature review. The variables studied will be; demand of innovation, financial management, risk management and intellectual property rights management. This section will discuss each of these barriers linking with the conducted literature review.

2.2.3.1 Demand of innovation

The demand for innovation is the first presumed barrier to innovation among Colombian service sector enterprises. Many authors and academic studies have argued that demand for innovation can

enhance innovation efforts from enterprises, and in the opposite way, the lack of it can constitute a barrier to innovation (Suárez-González & Galende, 1998, Edler, 2016, Mazzucato, 2013, Uyarra et al., 2014).

As discussed in the literature review, many authors like (Mazzucato, 2013) and (Edler & Georghiou, 2007) emphasize the important role of procurers to act as an efficient signaler of innovation to suppliers. Letting suppliers know what are the needs and the identified weaknesses of their activity can be in fact an efficient way to motivate suppliers to adapt their products offered or to invest resources in order to fill this demand (Uyarra & Flanagan, 2010).

2.2.3.2 Financial capabilities

Financial capacities for innovation is the second dependent variable of the model. According to the study of Corchuelo & Carvalho,. (2013, 14), the lack of financial capabilities is a significant barrier to innovation. It is obvious that in the presence of financial limitations, strategic investments such as R&D and the production of innovation is not a priority, although it holds the key to medium and long term financial stability.

Furthermore, Suárez-González & Galende, (1998) argued that enterprises with low financial capabilities prefer to destine their limited resources into activiries that grant the survival of the enterprise, such as daily operations and market expansions through traditional methods.

2.2.3.3 IPR management

The Intellectual Property Rights (IPR) variable is a very significant variable in a Latinoamerican country like Colombia, where this field still has a long way to improve. Throghout the conducted framework review, this study found that every research compared pointed at IPR management as a barrier to innovation due to its sensitive importance on incentivizing innovation, such as the studies of Suárez-González & Galende, (1998), Varsakelis, (2000), Uyarra et al., (2014) and Corchuelo & Carvalho, (2013) A perception of a strong IPR system may provide innovators the

guarantees to collect ownership of their inventions whenever they enter the market.

Although this topic is not enough discussed as a barrier of innovation in the Colombia, this study decided to include it as a barrier because of its relevance in the international context.

2.1.1.1 Risk management.

Risk is a big component of innovation. Entrepreneurs know best that no endeavor has a total chance of success, especially when it comes to innovation (Corchuelo & Carvalho, 2013). In the private sector world, business transactions take place taking into account some level of risk, assumed by the parts, financial instruments or insurance guarantees.

Furthermore, it is natural to assume that enterprises would feel more comfortable innovating with partners who are willing and able to take part of the risk of their endeavors. This type of setup is common in the private sector where venture capital companies make businesses with entrepreneurs; in this context, the risk of innovation is shared between the buyer and the producer. On the other hand, in the partnership between private and public sector, the management of risk is commonly absorbed by private enterprises. This is because public agencies are risk averse, according to the study of HM Treasury, (2005) conducted for the UK public agencies, and confirmed by the study conducted in the Colombian public sector by DNP (2021).

2.1.2 Moderating role of Information

The access to information is a key stone to every enterprise, especially in the process of innovation. The access to information can level the ground between different kinds of enterprises which can have a direct impact on the production of innovation. (Erridge & Nondi, 1994)

Every scholar in the field of public procurement of innovation highlights the great importance of a fluent communication between the procurers and the producers. The exchange of information, is

one of the main characteristics of the Perfect Competition market in classical economic theory, can be enhanced as a joint effort between market agents.

According to (Uyarra, Edler, Garcia-Estevez, Georghiou, & Yeow, 2014), the fluency of information that is produced in the interaction with procurer's organizations is a key enabler to innovate in the relationship between UK public sector suppliers and the UK public sector. This rationale claims the importance of a fluent communication between the two sides of the procurement process, the presence of this can constitute in an enabler to innovation.

In order to enhance information as an enabler, some studies have been approaching the topic with proposing different instruments such as the study of (Phaal, Farrukh, & Probert, 2004) which points to the usage of Technology Roadmaps in order to effectively signal needs and solutions in the relationship between ICT private sector and public procurement agencies.

Operatively, in an ecosystem of innovation that enhances the free flow of information, the experience gathered by the public sector being the principal responsible of providing determined service is highly valued, this experience on the administrative side can serve as an input to the supplier if it is transmitted opportunely. Depending on the scenario, this expertise can be related to the interaction between the public organizations and the end users.

On the other end, the experience gathered in the field by the supplier of services is highly valued because it can constitute the principal resource to improve the services offered, therefore opening doors to innovation.

Chapter 3. Colombian case analysis and the experience of other countries

3.1 Colombia: Implementing a public procurement policy of innovation

The inclusion of demand-side policies for innovation into the official document of national plannification didn't mean its direct implementation. Public Procurement of Innovation as the first strategy considered by the Colombian government, had only a "manual of operation" (Colombia Compra Eficiente, 2014), that de-facto functioned as a sociallization guide of the policy, but not as a operationalization document that allowed the policy tool to be completely implemented. It was only until mid-2022, that the namely inclusion of demand-side innovation policies on the National Strategic Plan, was decree and clearly frameworked by the National Planning Department[5] (where reached political consensus), allowing its operationalization and implementation.

During the history of PPI implementation in Colombia, various efforts have been conducted independently by decentralized governments (Medellin, Bogota) with not much empirical evidence of their success. These efforts were scattered not only because the mentioned unclear operationalization of the policy tool, but also by the lack of a centralized agency that imparts instructions and guidance on the implementation of the policy, or perhaps conduct the policy itself, as the case of UK and US. In Colombia, PPI policy in charge of the Public Procurement agency (Colombia Compra Eficiente) which at the same time responds to the National Planning Department and the recently created Ministry of Science Technology and Innovation, implying a vertical and non-autonomous organizational structure, damaging PPI governance.

Little have been achieved on PPI implementation in Colombia. Some governmental studies in the matter like the one conducted by DNP, (2020), points at the lack of culture of innovation on the

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[5] See DNP decree 442 of 2022: To promote Public Procurement of Innovation. Resource online: https://www.funcionpublica.gov.co/eva/gestornormativo/norma.php?i=184707#:~:text=Es

procurement managers of public agencies and the urgent need of reformation of the procurement normative framework, that reduce punishment out of public procurement managers.

On the other hand, the Colombian entrepreneurship ecosystem is large and has a big potential compared with Latin-Americans countries, according to the study of Zapata & Sinde, (2022). This ecosystem is characterized by a considerable number of Govtech initiatives, where public-private partnerships take place to solve challenges. This ecosystem can be enhanced by a proper implementation of PPI, according to Edler & Georghiou, (2007) and Zapata & Sinde, (2022).

To conclude with a broader perspective of the efforts towards innovation, the study of Zapata & Sinde (2022) also concluded that Colombia has one of the most sophisticated innovation policies of Latin-American, at least on the paper. This newly introduced policies have yet to be proven its efficiency in practice. Some of its features are, the creation of a Ministry of Science, Technology and Innovation (2018), the goal of double knowledge-sharing deals between academia and the private sector as well as double the investment on private-public partnerships (using policy tools like PPI).

3.2 Mapping other experiences: Implementing a public procurement policy of innovation

The most prominent cases of demand-side policies for innovation implementation are located in the UK, the United States and Germany (representing the most advanced implementation in the EU), according to the compilation made by Choi et al. (2015, 92).

The first case to review is the case of the United Kingdom. Public Procurement of Innovation (PPI) in the UK has several initiatives undergoing at the same time. Many of them focus on different fronts, some key initiatives are: Innovation Procurement Plans, Small Business Research Initiative (SBRI), Forward Commitment Procurement and Public-Private Procurement Compacts. A thorough analysis of the UK can be found in the study of Yeow et al (2013, 233-258).

Innovation Procurement Plan (IPP), an initiative launched by the Labour Government in a white

paper published in 2008 (DIUS, 2008). This initiative urged public institutions in the UK to evaluate their organizations in a retrospective manner and find areas and procedures where innovative ideas can be applied. After this first exercise, the initiative intended to embed innovative opportunities and adapt the public procurement of these institutions. According to Yeow et al., (2013) this program was discontinued due to the lack of measurable objectives, however it was a first attempt to draw a catalog of needs for innovation inside institutions, which after was replaced by a big reform of public procurement in the country.

The Small Business Research Initiative SBRI, is probably one of the most popular and successful PPI initiatives in Europe, according to (Yeow et al., 2013), their success is accounted for by adopting the experience gathered by the US Small Business Research Program, implemented 20 years earlier. The UK SBRI attempts to include Small Businesses into the public procurement process, funding them with R&D resources towards common objectives, including the innovation agenda discussed above.

After funding the research to develop innovative ideas, the SBRI would make a decision to purchase this innovation and use it for their activities (Izsak & Edler, 2011). This initiative has been producing fruits in many fields, benefitting UK citizens in areas like public transportation, security and defense, public health and IT (Lee et al., 2022).

The UK's SBRI initiative uses two policy tools in the procurement of innovation policy. First, uses the Pre-procurement of innovation that relates to the process of choosing and financing innovative ideas that solve public challenges, and afterwards it procures those ideas as explained. Through the use of Public Procurement of Innovation.

Another initiative of the UK is the Forward Commitment Procurement (FCP). Consist on taking one step back in the procurement cycle, compared to the SBRI initiative; aiming to communicate to the market the needs of the public sector that either are not available yet or are too expensive to purchase. This initiative requires fluent communication with the supply side and also commitment to purchase the prototyped product once it is ready to implement (Yeow et al., 2013).

The FPC highlights the importance of a partnership between the private and public sector. This partnership is the base of future inventions for more advanced public goods, but also allows private innovators to reduce the uncertainty that is implied in the innovation process, thanks to the intervention of a risk taker state. Such as the case exposed in the previous chapter about DAPRA in the United States, thoroughly studied by Block (2008).

Public-Private Procurement Compacts is a commitment to change buyer's behavior, in a joint effort between public and private sector to purchase certain technology (Yeow et al., 2013, 21). In the UK, this strategy is used to influence the green-technology market; first sounding new technologies and then buying them with a joint contribution from public and private organizations to stimulate the demand and meet carbon emission goals.

The four exposed initiatives in UK, related to PPI are defiant to traditional procuThe four exposed initiatives in UK, related to PPI are defiant to traditional procurement practices carried by the majority of countries. Challenges rationales of austerity, competition based tenders, state distance from the market, strategic procurement planning and a risk taker state, among other practices.

The second case to review is the United States. Although the US case was mentioned before several times as an example for state procurement of innovation policy, it is worth discussing its case in order to have a more complete idea of their efforts towards this kind of policy.

According to Mazzucato (2013); despite the "general perception" of the United States as a market led economy, the US government has carried out several policies of intervention especially when it comes to innovation. As mentioned before, innovation initiatives like DAPRA, the original Small Business Innovation Research (the precursor model of SBRI of the UK) and several more initiatives that made possible advances in climate change technology, are a clear example of the decisive intervention of the US government in the economy through PPI. In the next paragraphs we dig deeper on those initiatives.

One cannot start the discussion about United States innovation policies without any mention

about the second world war and its impact on state led technological funding. Block (2008) argued that despite the voices calling for an economy led by the market and a state limited to grant social welfare, like the New Deal of Franklin Roosevelt (Leuchtenburg, 2009). After the second world war, the United States had already experienced the benefits of investing public resources into innovations that led to nuclear energy, the internet and engines that later led man to the moon.

The agency in the center of all mentioned innovations is the Defense Advanced Research Projects Agency (DAPRA) formerly called ARPA. This agency was created by the US Pentagon, in 1958. It is an almost self-governed agency who responds to few Federal Government authorities, but does not depend on it, receives state-funding and enjoys complete freedom of research towards strategic goals.

DAPRA is characterized by a dynamic operation that engages with every step of the innovative process, its structure allows to close gaps between the academic "perfect world", the ambitious governmental goals and the "incremental technological development" (Mazzucato, 2013). Due to their short-term contracts, the agency managers are encouraged to make bold decisions that can be reoriented in the iteration process, a principal characteristic of every innovation. This level of freedom attracted high quality researchers that joined efforts in different areas, following the lead of agencies like DAPRA (Block, 2008).

According to Block (2008, 188), there are four features of the DAPRA model that can be a lesson to other models. First, the agency functions in small task forces, led by a senior researcher with a high autonomy of budget allocation and risk discretion. Second, the ultimate goal of the agency is to produce "usable technologies", so all efforts are oriented to get those innovations to a "commercialization stage", this characteristic describes the complete approach of the agency on the innovation process.

Third, according to Block (2008, 188), funding is granted to researchers from academia, stat-ups and private R&D firms, and the allocation of this fundings is on a results basis, cutting off fundings from groups with low productivity. Finally, the role of the agency goes beyond funding and researching,

but also acquires functions of connecting means to ends. Utilizing their network and their close relationship with stakeholders to accelerate the innovation process and until the phase of commercialization.

Another important PPI initiative in the US is the Small Business Innovation Research programme (SBRI). This programme is important because "fulfills a unique role in the innovation ecosystem", something like a Public Venture Capital that grants more than 2 billion USD per year, (Mazzucato, 2013, 74). This programme functions as the first resource an entrepreneur has when starting their technology based venture. Furthermore, this initiative works closely to entrepreneurs, following the efforts in every step of the process until the commercialization phase.

Paradoxically, the relevance of SBIR is also based on the characteristics of private Venture Capitals (VC), this type of organizations expect short term return of their investment and "seek early exit through IPOs" (Mazzucato, 2013, 75). On the other hand, SBIR seeks to reach the phase of commercialization of the funded innovations. Showing a strong commitment that also attracts a larger number of entrepreneurs.
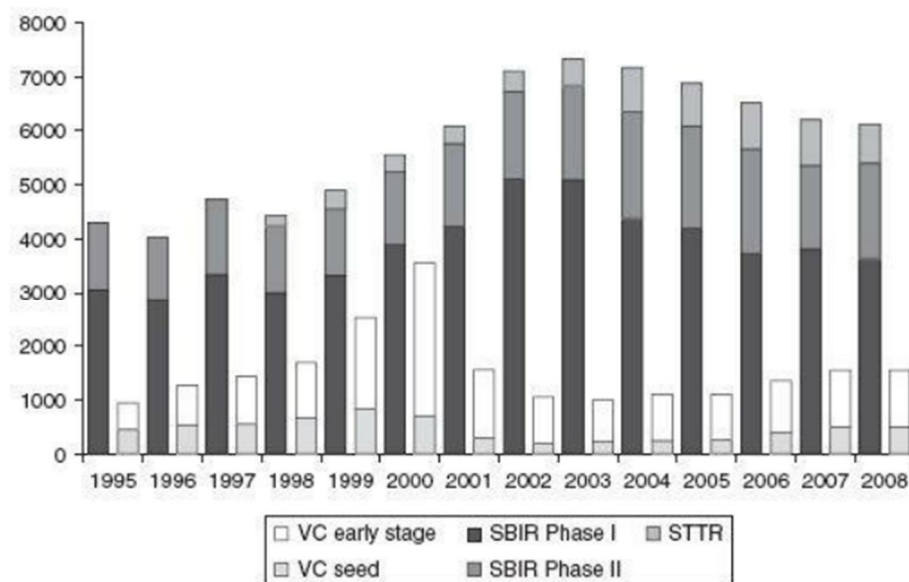

Figure 5 Early stage startups financed by Venture Capital organizations and SBIR (1995-2008) Block & Keller (2015,12)

The described phenomenon is shown in Fig. 5, where Block & Keller (2015,12) compares

Venture Capital investments on start-ups vs the investment of SBIR in the period between 1995 and 2008. Startups prefer the SBIR funding rather than VC's because of their commitment to their initiatives and their support until the final phase of the innovation process.

The last case to review PPI policies is Germany. Germany is one of the most prominent countries in this type of policy. According to Czarnitzki et al (2018), Germany is the forerunner of PPI policies in Europe, due to the early adaptation of their public procurement regulatory framework, back in the year of 2009. This early adaptation allowed many PPI initiatives to take place in the short term, turning the country into an experiment for the other countries to learn.

As mentioned, the first measure the German government took to adopt PPI policies was the reform of the public procurement regulatory framework. Commonly, public procurement laws tend to mandate public managers to overspecify their requirements in tenders, aiming to measure the products or services purchased, decrease the level of uncertainty in the deal and offer transparency to the public. However, public procurement of innovation requires another rationale, to transit from "traditional tender specifications", to "specify procurement needs in terms of functional requirements" (Czarnitzki et al., 2018, 9), this is exactly what was reformed in the public procurement regulatory framework in Germany, back in 2009.

Furthermore, the introduction of new regulations coincided with a policy of upskilling public servants on innovative procurement. This initiative allowed the fast application of the new framework, according to (Czarnitzki et al., 2018, 9), which opened the door to innovators to participate in public tenders. Later on, the German government launched the Competence Center for Innovative Procurement (KOINNO) initiative in 2014. This initiative assumed several roles in the innovation policy such as building an ecosystem of innovation, connecting suppliers (especially SMEs) to public organizations, supported pre-commercial procurement initiatives and finally upskilling of public servants. (OECD, 2017)

Having briefly reviewed the main PPI country cases, we can sum up their experiences on key strategies implemented for their success. The case of the United Kingdom had important characteristics

of strategic planning from the beginning of the policy (initiatives like IPP and FPC), combined with a permanent socialization of these strategies with the private stakeholders. Moreover, the government has a close partnership with the private sector to meet common needs through research, funding and support on commercialization (SBRI).

The case of the United States also has several lessons to highlight; the budget autonomy and discretion of decision making from innovation agency managers, allows organizations to conduct research freely and take risks on early stage start-ups. These characteristics attract bold ideas as well as high-skilled researchers (DAPRA). Moreover, building confidence between private and public sectors boosts their interaction and fluency of novel ideas, such an example can be found in the SBIR. Finally, the case of Germany leaves as the lesson of reforming the procurement legislation framework, from "traditional tender specifications", to "specify procurement needs in terms of functional requirements" (Czarnitzki et al., 2018,).

Chapter 4. Research design

This chapter will discuss the design of the investigation which includes the methodology of the research, the operationalization and conceptualization of the variables, the hypothesis and the analytical framework. In a general view, this research uses secondary data, collected by the National Statistics Authority of Colombia (DANE), about the innovation practices in the service sector of the economy. Furthermore, this research will be supported on an extensive literature review, including journals, books and country reports in order to add consistency to the case study.

4.1 Analytical framework

4.1.1 Model 1. Determinants of the Barriers to innovate for public sector providers

Figure 6 Model 1. Determinants of the Barriers to innovate for public sector providers.
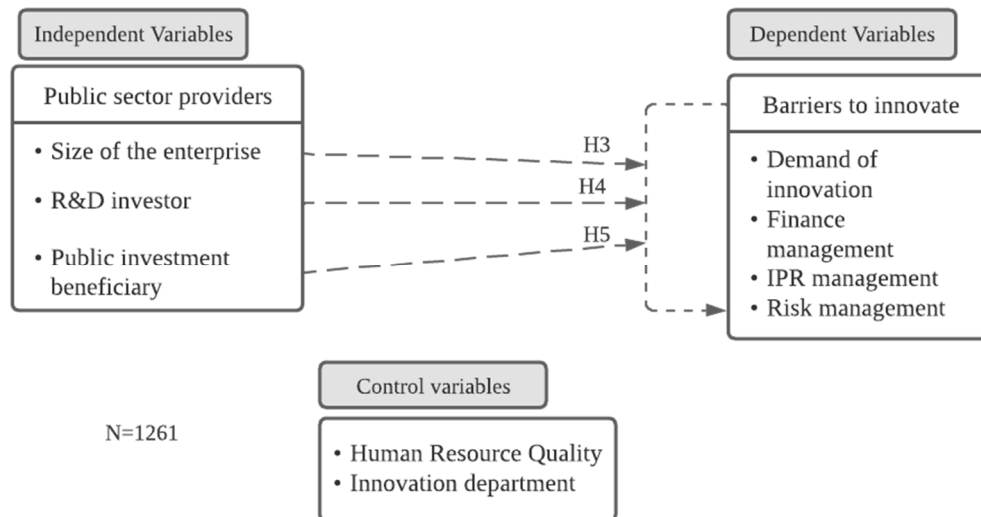
The model 1 analyzes the determinants of the barriers to innovation determined through the literature review, utilizing the only the public sector providers, which accounts for 1.261 enterprises. This model includes the size of the enterprise, the intensity of R&D investment and public investment beneficiary as determinants, tested against the barriers to innovation with the public sector. Furthermore, the model includes 2 control variables to characterize the enterprise such as the quality of Human Resources and the possession of an innovation department. Finally, this model suggests a moderator role of the perceived innovation constraints.

4.1.2 Model 2. Moderator effect of Information in the determinants of the Barriers to innovate for public sector providers

Figure 7 Model 2. Determinants of the Barriers to innovate for public sector providers. Information as moderator
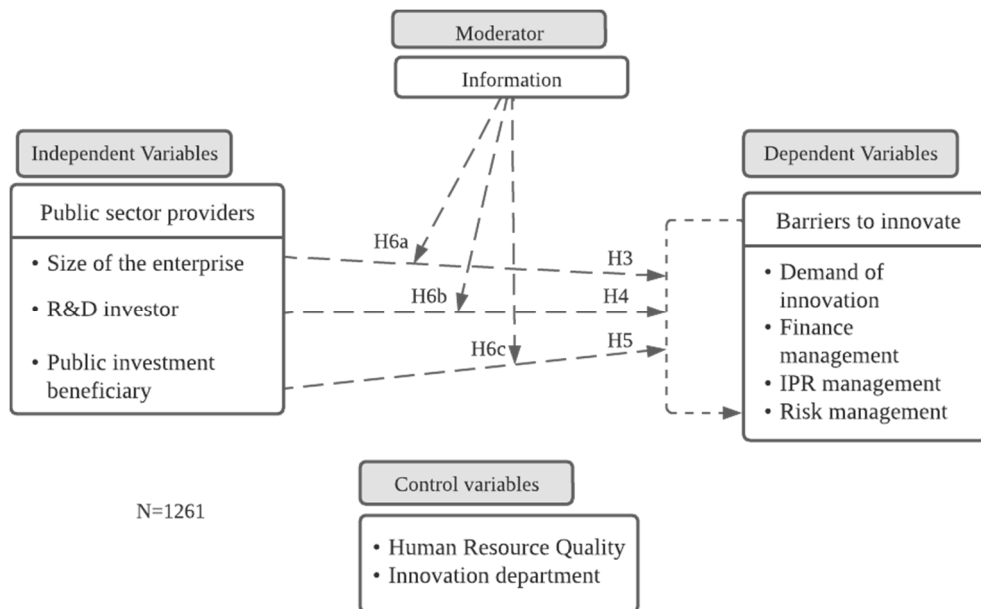
The model 2 analyzes the moderator effect of information in the relationship between the public sector providers and the identified barriers to innovate. This model includes the size of the enterprise, the intensity of R&D investment and public investment beneficiary as determinants, tested against the barriers to innovation with the public sector. Furthermore, the model includes 2 control variables to characterize the enterprise such as the quality of Human Resources and the possession of an innovation department, and finally the moderator variable, as Information.

4.2 Hypothesis and discussion of the variables

This research digs into the barriers of innovating with the Colombian public sector from the perspective of the enterprises that provides services to them. In the theoretical analysis, this study was able to determine 4 barriers to innovation that have relevance for providers of the Colombian public sector. A more complete analysis should approach the determinants of those barriers given the characteristics of the providers, in order to have clear measures to overcome them.

Hypothesis 1. The size of the enterprise is a significant determinant of the perception of barriers to innovating with the public sector.

The first hypothesis tests the size of the enterprises who provide services to the public sector as a determinant factor to perceive barriers of innovation. The research of Uyarra et al., (2014) and Corchuelo & Carvalho, (2013) studied thoroughly this variable impact on the demand of innovation and risk aversion as barriers for the case of United Kingdom and Spain respectively. They concluded that small enterprises perceive with more intensity demand of innovation and the risk management as barriers. Furthermore, the study of Suárez-González & Galende, (1998, 11) finds that financial capabilities as a barrier of innovation increases its perception for smaller enterprises.

Hypothesis 2. Public sector provider's investment in R&D is a significant determinant of the perception of barriers to innovating with the public sector.

The second hypothesis of this research accounts for the role of R&D level of investment on the barriers to innovating with the public sector. According to Uyarra et al., (2014) the R&D investor enterprises perceive the demand of innovation with more intensity than enterprises who don't invest in R&D due to the expectancy of returns of their investment. Furthermore, in the case of risk management and IPR management as barrier, enterprises who invest in R&D may find this barrier as irrelevant, because R&D investment implies willingness to take risk.

Hypothesis 3. Receiving public investment is a significant determinant of the perception of barriers to innovating with the public sector

The third hypothesis of this research tests the influence of being beneficiary of public investment on the perception of the barriers of innovating with the public sector. It is natural to think that receiving public investment may reduce the perception of barriers like financial management, demand of innovation and risk management, this assumption is supported by the conclusions of the study of Suárez-González & Galende (1998), where instruments like direct investment on R&D projects are suggested to include in the public policy of innovation.

Hypothesis 4. Access to Information moderates the relationship between the public sector providers (size of the enterprises, the R&D investor enterprises, public investment beneficiaries) and the perception of barriers to innovation.

The fourth hypothesis tests the moderator role of Information as a moderator variable on the relationship between the enterprises that provides services to the public sector, classified by their size, R&D intensity and public investment beneficiaries, and the perception of barriers to innovate. Uyarra et al., (2014) and Mazzucato (2013) argued that the flow of information can be perceived differently depending on the enterprise as its access can be limited and may depend on other factors, moreover it can become an enabler of innovation reducing the perception of several barriers of innovation.

4.2.1 Conceptualization and operationalization

4.2.1.1 Independent variables

This research follows the approach of Uyarra et al., (2014) and Corchuelo & Carvalho, (2013) arguing that the perception of barriers of innovation can be different depending on the characteristics of the enterprise such as, the size, R&D investment and Public Investment beneficiary. *Models 1 and 2*, tests the determinants of barriers to innovating with the public sector.

The size of the enterprise is included in the model under the name of "size". This variable is especially relevant due to the Innovation Theory posed by Schumpeter (1961) and empirically proved by studies like (Suárez-González & Galende, 1998), therefore, assessing the barriers to innovation given their size is a key component of this study.

The variable *R&D investment* accounts for the usage of investment on R&D by the surveyed enterprise. This variable is included in the model under the name of "RD". The inclusion of this variable will help to divide in subgroups the sample from the ones that are intensive R&D investors to the ones who are not, and then analyze the perceived impact of barriers.

The variable Public Investment Beneficiary, divides the enterprises who received public investment to the ones who didn't (Fundación Suiza de Cooperación para el Desarrollo Técnico, 2020). This variable is included in the model as "PI".

4.2.1.2 Dependent variables

As discussed in Chapter 2, Theoretical background, this study will include four dependent variables, such as demand of innovation, financial management, IPR management and risk management.

Demand of innovation (Suárez-González & Galende, 1998, Edler, 2016, Mazzucato, 2013, Uyarra et al., 2014): this variable is included in the model under the name of "demand". Financial management (Corchuelo & Carvalho,. 2013): This variable is included in the model under the name of "finance". IPR management (Suárez-González & Galende, 1998: this variable is included in the model under the name of "IPR". Risk management (Corchuelo & Carvalho, 2013): this variable is included in the model under the name of "risk".

4.2.1.3 Moderator variable

The moderating variable in *Model 2* is Access to Information, following the approach of (Erridge & Nondi, 1994): this variable is included in the model under the name of "Info", and its data comes from the survey question "Indicate the perception of low information about public instruments and interaction with public procurers".

4.2.1.4 Control variables

Control variables plays the role of a secondary characterization of the studied enterprises, following the approach of (Fundación Suiza de Cooperación para el Desarrollo Técnico, 2020). This research will include the percentage of HR quality and the possession of a department of innovation as the main moderator variables in the two models.

4.3 Methodology

This study adopts a case study design to determine perceived barriers to innovate with public organizations from the Colombian service sector perspective, furthermore, this research will study the

determinants of those barriers perceived exclusively for enterprises that provide services to the public sector with the moderator role of information, and finally this study will suggest solutions to overcome these barriers. The case study design allows us to design qualitative research that identifies the possible barriers, and link the findings with an extensive analysis of Colombian and other countries' experiences in order to fulfill this paper objectives.

The data for the quantitative analysis is obtained from the 2019-2018 National Survey of Development, Innovation and Technology[6], conducted by the National Department of Statistics of Colombia. For the data analysis, this study will explore 2 models, the first model will test the characteristics of public sector service providers as determinants of the perception of barriers to innovate through a generalized linear model. Finally, using the same statistical method, model 2 will test the moderator role of information between the characteristics of enterprises and the perception of barriers to innovate.

4.3.1 Data source

This study is using the latest survey available to the date of this investigation, the EDITS Services and Commerce (2018-2019). This survey collected the data of 9.304 private enterprises of the Service and Commerce sector, during the timeframe of february-july of 2020. The methodology implemented was a self-administered survey using an electronic form posted in DANE (National Statistics authority) website. This survey utilizes the 12 classifications of innovation, stated in the Oslo Manual of 2018, which includes the introduction of novelties, processes or innovation in the final product. The present investigation and the survey used coincide in using a holistic definition of innovation, discussed in the first section of the second chapter of this document.

With a total of 729 variables collected, the survey studies all types of innovative practices, characteristics of the enterprises and innovation enablers, like human resources, financial aspects and

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[6] Visit the microdata webpage of the National Department of Statistics of Colombia. https://microdatos.dane.gov.co/catalog/699/get_microdata

R&D activities. In the case of this study, only 10 variables are analyzed; 3 independent, 4 dependent, 2 control and 1 moderator.

Moreover, the total of enterprises surveyed originally by DANE is narrowed down for the purpose of this study. The enterprises that provide services to the public sector and responded to the questions formulated about the barriers of innovation are the scope of this study, which at the same time, described their innovation practices or their intention to innovate; a total of 1.261 enterprises, accounting for 13,5% of the initial amount of surveyed enterprises.

4.3.2 Research instrument

This study utilizes the mentioned survey conducted by the National Department of Statistics of Colombia on innovation in the services sector. For the purpose of this research inquiry, this study will pick the relevant questions to include them as variables in the quantitative study.

The independent variables can be found in the survey section of the characterization of enterprises and innovation activities, where questions related to personnel management and destination of enterprises resources towards innovation are asked.

The variable size of the enterprise "Size", gathers the data from the survey question, "How many people were occupied in the last year by the company?" For purposes of normalization of the variable, a logarithm of this variable is conducted.

The variable R&D investment "RD", collects its data from the survey question. "Declare the amount of money invested in R&D activities in the year of 2018". For the purpose of this research, this variable is recoded as binary, "0" meaning no investment and "1" meaning investment on R&D.

The variable Public Investment beneficiary "PI", collects its data from the survey question. "Declare the amount of public investment received by your enterprise in the year of 2019, if not leave 0". For the purpose of this research, this variable is recoded as binary, "0" meaning no public investment received and "1" meaning public investment received.

The dependent variables can be found in the survey section of perceived barriers to innovation, where the 4 barriers subject of this study were tested among others. The perception of barriers are classified in 3 levels, "1=perceived", "2=moderately perceived" and "3=not perceived".

The barrier of demand of innovation, included in the model as "demand", collects its data from the survey question "Is the uncertainty of demand for innovative services or goods an obstacle to introducing new processes, improvements or novelties in your enterprise?" The perception of this barrier is classified in 3 levels, "1=perceived", "2=moderately perceived" and "3=not perceived".

The barrier of finance management, included in the model as "finance", collects its data from the survey question "Is the lack of own resources an obstacle to introduce new processes, improvements or novelties in your enterprise?" The perception of this barrier is classified in 3 levels, "1=perceived", "2=moderately perceived" and "3=not perceived".

The barrier of IPR management, included in the model as "IPR", collects its data from the survey question "Is the IPR system an obstacle to introducing new processes, improvements or novelties in your enterprise?" The perception of this barrier is classified in 3 levels, "1=perceived", "2=moderately perceived" and "3=not perceived".

The barrier of risk management, included in the model as "risk", collects its data from the survey question "Is the uncertainty to successfully execute the innovation an obstacle to introduce new processes, improvements or novelties in your enterprise?" The perception of this barrier is classified in 3 levels, "1=perceived", "2=moderately perceived" and "3=not perceived".

The control variables utilized in this research play a role of support to the characterization of the enterprises, such as the Human Resources Quality and the possession of department of innovation.

The Human Resources Quality is included in the model under the name of "HR", and is calculated following the compound of survey questions as "Indicate how many employees your enterprise has depending on the academic achievement". The percentage is a division between number of employees with a bachelor's degree and above, and the total amount of employees.

The possession of a department of innovation is included in the model under the name of "Lab" and its data comes from the survey question "Indicate the average amount of employees dedicated to R&D activities". This variable is recoded as binary where the average amount of employees dedicated to R&D activities is more than 0, as follows "1=possession of R&D department" and "0= not possession of R&D department".

Finally, the moderator variable Information is included in the model as "Info", and its data comes from the survey question "Indicate the perception of low information about public support instruments". The perception of this barrier is classified in 3 levels, "1=Informed", "2=moderately informed" and "3=not informed".

Table 3 Measurement and variables used in the study. Data gathered from EDIT survey

Type of variable	Variable	Reference	Construction
Independent Variable	Size of the enterprise	Uyarra et al., (2014) and Corchuelo & Carvalho, (2013))	Log of number of employees.
	R&D investment	(Uyarra, Edler, Garcia-Estevez, Georghiou, & Yeow, 2014)	0 = no investment in R&D in 2019 1 = invested in R&D in 2019
	Public investment beneficiary	(Fundación Suiza de Cooperación para el Desarrollo Técnico, 2020).	0 = didn't receive in 2019 1 = Received in 2019
Dependent variables	Demand of innovation	(Suárez-González & Galende, 1998) (Corchuelo & Carvalho, 2013) (Uyarra et al., 2014)	1 = perceived 2 = moderately perceived 3 = Not perceived
	Financing management	(Corchuelo & Carvalho, 2013) ((Uyarra et al., 2014)	1 = perceived 2 = moderately perceived 3 = Not perceived
	IPR management	(Suárez-González & Galende, 1998) (Uyarra et al., 2014) (Varsakelis, 2000 (Corchuelo & Carvalho, 2013)	1 = perceived 2 = moderately perceived 3 = Not perceived
	Risk management	(DANE, 2019) (Erridge and Nondi, 1994) (Uyarra, Edler, Garcia-Estevez, Georghiou, & Yeow, 2014)	1 = perceived 2 = moderately perceived 3 = Not perceived
Control Variables	Human Resources Quality	(Fundación Suiza de Cooperación para el Desarrollo Técnico, 2020)	Percentage of quality

| | Lab | (Fundación Suiza de Cooperación para el Desarrollo Técnico, 2020) | 0 = no department of R&D 1 = department of R&D |
| Moderator Variable | Information | (Erridge & Nondi, 1994) | 1 = Informed 2=Moderately informed 3 = Not informed |

4.3.3   Data analysis method

The data analysis will be conducted utilizing statistical methods through the SAS software. As a first step, the complete survey of the National Statistics Authority of Colombia is uploaded to the software where all the relevant variables are renamed and recoded if necessary. As a second step, this research made a correlation analysis, a VIF and Tolerance test on all independent and control variables utilized in the models, moreover a descriptive analysis of dependent, independent and moderator variables is provided. To answer the formulated hypothesis, two models are tested.

The first model tests the characteristics of public sector providers as determinants of barriers to innovation (as continuous variables), utilizing a Multiple OLS Regression. The second model utilizes the same statistical method to test the moderator role of information on the relationship between the characteristics of public sector providers and the barriers to innovation.

Chapter 5. Data analysis and findings

This chapter will analyze the empirical data and the findings, product of the statistical methods applied using the SAS software. Walking through the descriptive statistics of the data utilized, this section will arrive to the discussion of the four hypothesis stated in the last chapter, which results will be thoroughly compared with the theoretical background in the sixth chapter.

5.1 Descriptive analysis

Table 4 Characterization of service sector enterprises. Dependent, Independent, Control and Mediator variables

Type of variable	Variable	Level	Frequency	Percentage
Dependent Variables	Demand of Innovation	1 = perceived	240	19%
		2 = moderately perceived	568	45%
		3 = Not perceived	453	36%
	Finance Management	1 = perceived	313	25%
		2 = moderately perceived	541	43%
		3 = Not perceived	407	32%
	Risk Management	1 = perceived	164	13%
		2 = moderately perceived	621	49%
		3 = Not perceived	476	38%
	IPR Management	1 = perceived	153	12%
		2 = moderately perceived	463	37%
		3 = Not perceived	645	51%
Independent Variables	Size of the enterprise	Less than 10 employees	14	1%
		Less than 50 employees	205	16%
		Less than 250 employees	596	47%
		Less than 500 employees	177	14%
		More than 500 employees	269	21%
	R&D Investor	Not investor	907	72%
		Investor	354	28%
	Public Investment beneficiary	No public investment	1174	93%
		Public investment	87	7%
Control Variables	Human Resources (Quality)	Less than 25% highly qualified	462	37%
		Less than 50% highly qualified	401	32%
		Less than 75% highly qualified	233	18%
		More than 75% Highly qualified	165	13%
	Innovation Department	No department of R&D	205	16%
		Department of R&D	1056	84%
Moderator Variable	Information Access	1 = perceived	132	10%
		2 = moderately perceived	458	36%

		3 = Not perceived	671	53%

An overview of the dependent variables utilized in this study is shown in the first section of Table 4. The descriptive statistics of these four variables helps to build a broad understanding of the intensity of perceived barriers in the studied enterprises. It is relevant to mention the intensity of the barriers; the financial capacity, demand for innovation and risk management. Adding up to the top three perceived barriers to innovating by enterprises, this study decided to add a fourth barrier to innovating, according to the literature review conducted in the second chapter of the document; the IPR management.

The characterization of the enterprises studied is conducted by the independent variables with the support of the control variables, the basic statistics about this characterization can be found in Table 4.

Starting the analysis of the independent variable Size, this study subdivided this variable following the OECD classification of SME's in a scale of 5, for the purpose of the descriptive analysis. As shown in the Table 4, the gross of the sampled enterprises are located in the 2nd group, more than 50 employees and less than 250. This portion of enterprises accounts for almost the half of the sample 47% with a total of 596 enterprises. Meaning a prevalence of SME's in the sample. Moreover, it is worth noticing that 61% of the enterprises, about 269, are large enterprises with more than 500 employees, giving this group a huge participation in the study.

In the classification about R&D investment, 72% of the enterprises reported cero investment in R&D activities in the previous year. This characteristic is worth to be highlighted because it can express one side of the culture of innovation in the services sector.

The Human Resources (quality) classification of the sample, accounts for the level of education of the enterprise, comparing personnel with more than a bachelor's degree. It is worth noticing that 37% of the service sector enterprises in this sample reported less than 25% of high qualified personnel, while only 13% of the enterprises have 75% or more of their employees highly qualified, about 165

enterprises.

The last classification of this characterization of the sample is the possession of a Innovation Department. As shown in Table 4, 84% of the enterprises reported having a department for innovation activities, accounting by 1.056 enterprises.

5.1.1 Determinants of the Barriers to innovate for public sector providers

This model tests the determinants of the barriers to innovation. It should be noted that the scale of barriers to innovation is 1=perceived to 3=not perceived, therefore, a higher average in comparison to others, means a low perception and a lower average means a high perception of the barrier.

Table 5 Descriptive Stat. of determinants and the barriers to innovate

	Level	N	Demand of innovation		Finance Management		IPR		Risk management		Note: Barriers to innovation classified in a scale of 1=perceived to 3=not perceived)
			Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	
Size of the enterprise	< 10 employees	14	1.93	0.73	1.86	0.77	2.21	0.80	2.07	0.73	
	< 50 employees	205	2.20	0.76	2.06	0.76	2.52	0.65	2.32	0.69	
	< 250 employees	596	2.19	0.71	2.12	0.74	2.55	0.62	2.24	0.67	
	< 500 employees	177	2.16	0.74	2.06	0.76	2.55	0.64	2.19	0.68	
	> 500 employees	269	2.11	0.71	2.00	0.77	2.55	0.62	2.25	0.64	
R&D Investor	Not investor	907	2.21	0.72	2.10	0.75	2.55	0.62	2.19	0.66	
	Investor	354	2.07	0.71	2.02	0.75	2.51	0.65	2.27	0.68	
Public Investment beneficiary	No public investment	1174	2.18	0.73	1.86	0.75	2.55	0.62	2.25	0.67	
	Public investment	87	2.05	0.65	2.09	0.75	2.39	0.72	2.20	0.63	

Table 5 uses the independent variables in this model, tested as determinants of barriers, to compare them with the barriers of innovation in a basic analysis of statistics. First, it can be noted that, in the case of Demand of innovation as a barrier, its perception is higher in terms of mean for enterprise with less than 10 employees, accounting for 1,93 (SD:0,73) about 14 enterprises of the sample.

Second, in the case of Finance management as a barrier, its perception is higher in terms of mean in enterprises with less than 10 employees, 1,86 (SD:0,77). Moreover, the perception of financial

management is lower when the enterprise was beneficiary of public investment than when did not, with a difference of means of 0,21 points.

In the case of the third barrier of innovation, IPR management, its average perception is higher in companies that did not invest in R&D activities and neither receive public investment, 2,55 (SD:0,62) for both of them.

In the case of the forth barrier to innovation, Risk management, its perception in average is higher for enterprises with less than 10 employees, 2,02 (SD:0,73), moreover, the average perception of this barrier is higher also in enterprises who didn't invest in R&D activities 2,19 (SD:0,66).

Table 6 Descriptive Stat. of control variables and the barriers to innovate

	Level	N	Demand of innovation		Finance Management		IPR		Risk management		*Note: Barriers to innovation classified in a scale of 1=perceived to 3=not perceived)*
			Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	
Innov. Departm ent	No R&D lab	205	2.23	0.74	2.04	0.78	2.52	0.66	2.28	0.66	
	R&D lab	105 6	2.16	0.72	2.08	0.75	2.54	0.63	2.24	0.67	
Human Resour. (Quality)	< 25% highly qualified	462	2.21	0.74	2.19	0.71	2.53	0.64	2.26	0.69	
	< 50% highly qualified	401	2.18	0.70	1.93	0.78	2.56	0.62	2.22	0.67	
	< 75% highly qualified	233	2.09	0.72	2.08	0.76	2.58	0.61	2.24	0.66	
	> 75% Highly qualified	165	2.12	0.71	2.09	0.73	2.47	0.65	2.28	0.63	

Finally, Table 6 shows the descriptive statistics of the control variables which help characterizing the enterprises studied in model 1. In the case of Demand of innovation as a barrier, the average perception is higher in enterprises who don't possess an Innovation department 2,23 (SD:0,74). Moreover, for Finance management as a barrier and Demand of Innovation, the effect is similar on the Human Resources qualification because their perception is higher for enterprises with less than 50% of their personnel qualified, 1.93 (SD:0,78).

5.1.2 Tolerance and Variance Inflation Factor (VIF) test

Table 7 Tolerance and VIF

Variable	Variable code	Tolerance	Variance Inflation
Log (Size of the enterprise)	LogSize	0.854	1.170
R&D Investor	RD	0.649	1.541
Public Investment beneficiary	PI	0.730	1.369
Human Resour. (Quality)	HR	0.939	1.064
Innov. Department	Lab	0.943	1.060
Access to Information	Info	0.993	1.007

This research conducted a Tolerance and Variance Inflation Factor test to assess multicollinearity problems in the model. This test has conducted in Independent Variables (R&D investor, Public Investment beneficiary), Control variables (Innov. Department and Human Resources Quality) and the moderator variable, Information. The results on this table can be analyzed as follows: if the Tolerance indicator is > 0.1 or VIF number < 5, it indicates the absence of multicollinearity.

As shown in Table 7, the column of outcomes in the Tolerance column are above 0.1, moreover the outcome in VIF column are all below 5. In conclusion, the test conducted in SAS indicates that there is no problem of multicollinearity between the tested variables.

5.2 Hypothesis testing

To answer hypothesis formulated, this research conducts a Pearson's Correlation test (Table 8) and a Multiple OLS Regression (Table 9) to determine the relationship between the independent variables and the barriers to innovation, formulated in model 1, furthermore, with the same procedure, this study will determine the role of Access to Information as moderator formulated in model 2.

Table 8 Pearson's correlation coefficient

	Logsize	RD	PI	Demand	Finance	IPR	Risk	Info	Lab	HR
Size of the enterprise *(Independent)*	1									

R&D Investor *(Independent)*	0.33***	1								
Public Investment beneficiary *(Independent)*	0.05**	0.44***	1							
Demand *(Dependent)*	-0.04	-0.09***	-0.05*	1						
Finance *(Dependent*	-0.03	-0.07***	-0.1***	0.33***	1					
IPR *(Dependent*	-0.01	-0.05	-0.03	0.40***	0.25**	1				
Risk *(Dependent*	-0.02	-0.06**	-0.03	0.69***	0.35**	0.38***	1			
Information *(Moderator)*	0.04	-0.05*	-0.09***	0.42***	0.34***	0.39***	0.41***	1		
Innov. Department *(Control)*	0.14***	0.21***	0.13***	-0.06**	-0.02	-0.07**	-0.04	-0.01	1	
Human Resour. *(Control)*	0.12***	0.16***	0.16***	-0.07***	-0.05**	-0.0276	-0.003	-0.02	0.02	1

*Note 1: *** p<0,01, ** p<0,05, * p<0,1*
Note 2: N=1.296, all type of enterprises, public and private providers.
Note3: Logsize: Logarithm of Size, RD: R&D investment, PI: Public investment beneficiary,
Info: Information. Lab: Innovation department, HR: Human Resources Quality

Table 9 Multiple OLS Regression on barriers to innovation (Model 1 and 2)

	Model 1				Model 2			
	Demand of innov	Finance manag,	IPR manag,	Risk manag,	Demand of innov.	Finance manag.	IPR manag,	Risk manag.
Size of the enterprise	-0.0008 (0.0366)	-0.0209 (0.0382)	0.0145 (0.0353)	0.0042 (0.0341)	-0.46*** (0.0518)	-0.39*** (0.0559)	-0.43*** (0.0501)	-0.47*** (0.0482)
R&D Investor	-0.101** (0.0511)	-0.04 (0.0532)	-0.0476 (0.0492)	-0.083** (0.0475)	0.0094 (0.1735)	-0.0297 (0.1876)	0.1871 (0.1681)	0.2207 (0.1616)
Public Investment beneficiary	-0.0068* (0.0661)	-0.17*** (0.0694)	-0.0087 (0.0642)	-0.0014 (0.0619)	-0.2991 (0.2119)	-0.3039 (0.229)	-0.3329 (0.2053)	0.0462 (0.1973)
Innov. Department	-0.1145 (0.0666)	-0.0162 (0.0739)	-0.16** (0.0683)	-0.0672 (0.0659)	-0.1117* (0.0651)	-0.0145 (0.0703)	-0.158** (0.063)	-0.0629 (0.0606)
Human Resour. (Quality)	-0.16** (0.0788)	-0.112 (0.0821)	-0.0571 (0.0759)	0.0156 (0.0733)	-0.150** (0.0723)	-0.1016 (0.0782)	-0.0454 (0.0701)	0.0274 (0.0673)
Size of the enterprise *information					0.18*** (0.0159)	0.14*** (0.0172)	0.17*** (0.0154)	0.19*** (0.0148)
R&D Investor * information					-0.15** (0.0164)	0.0005 (0.074)	-0.0905 (0.0663)	-0.119** (0.0637)
Public Investment beneficiary * information					0.1516* (0.0864)	0.0756 (0.0934)	0.161** (0.0837)	0.208** (0.0135)
N	1261	1261	1261	1261	1261	1261	1261	1261
R2	0.0132	0.0132	0.0073	0.0049	0.2611	0.1075	0.15657	0.2909
Fvalue	3.37	3.35	1.85	1.25	32.31	18.86	29.05	30.03

5.2.1 Testing hypothesis 1

The hypothesis 1 in this research is "The size of enterprise is a significant determinant of the perception of barriers to innovate with the public sector". To test this hypothesis, this study looks at the Pearson's correlation displayed in Table 8 and the Multiple OLS Regression displayed in Table 9.

Pearson's correlation displayed in Table 8 determined that the Size of the enterprise does not reach significance in its relationship with any of the barriers. This same situation happens when looking at the Multiple OLS Regression in Table 9. The size of the enterprise does not reach significance when evaluating its relationship with any of the barriers to innovation, and its estimates are close to cero, meaning that the probability of explaining the dependent variables is low.

The conducted statistical procedures allows this study to accept null-hypothesis and affirm that the variable size of the enterprise is not statistically significant to any of the dependent variables (Demand of innovation, Finance management, IPR management and Risk management).

5.2.2 Testing hypothesis 2

The hypothesis 2 in this research is "Public sector provider's investment in R&D is a significant determinant of the perception of barriers to innovating with the public sector" To test this hypothesis, this study looks at the Pearson's correlation displayed in Table 8 and the Multiple OLS Regression displayed in Table 9.

In the case of Demand of innovation as barrier, Pearson's correlation displayed in table 8, shows that the correlation coefficient between Investment in R&D and Demand of Innovation is -0,09 with an alpha level of 0,01, allowing to confirm that there is a statistical association between the two variables. Furthermore, looking at the Multiple OLS Regression in Table 9, the estimate of -0,1 suggests that there

is a negative relationship between this two variables, which implies that investing in R&D decreases the perception of Demand of innovation as a barrier for public provider enterprises, as the p-value is lower than 0,01.

In the case of Finance management as barrier, Pearson's correlation displayed in table 8, shows that the correlation coefficient between Investment in R&D and Finance management is -0,07 with an alpha level of 0,01, allowing to confirm that there is a statistical association between the two variables. Furthermore, looking at the Multiple OLS Regression in Table 9, the estimate of -0,04 suggests that there is a negative relationship between this two variables, which implies that investing in R&D decreases the perception of Finance management as a barrier for public provider enterprises, as the p-value is lower than 0,01

In the case of IPR management as barrier, Pearson's correlation displayed in Table 8 determined that Investment in R&D does not reach significance in its relationship with IPR management as a barrier. This same situation happens when looking at the Multiple OLS Regression in Table 9. The level of Investment in R&D does not reach significance when evaluating its relationship with IPR management, and its estimate is close to cero, meaning that the probability of explaining the dependent variable is low.

In the case of Risk management as barrier, Pearson's correlation displayed in table 8, shows that the correlation coefficient between Investment in R&D and Risk management is -0,06 with an alpha level of 0,01, allowing to confirm that there is a statistical association between the two variables. Furthermore, looking at the Multiple OLS Regression in Table 9, the estimate of -0,08 suggests that there is a negative relationship between this two variables, which implies that investing in R&D decreases the perception of Risk management as a barrier for public provider enterprises, as the p-value is lower than 0,01

The conducted Pearson's correlation procedure allows this study to confirm that the Investing in R&D holds a statistically significant correlation with the barriers of innovation (except IPR

management). Moreover, the Multiple OLS Regression allows to confirm that there is a statistical relationship of Investing in R&D and the barriers to innovate (except IPR management) is negative and statistically significant. However, it's worthy to notice that the R^2 in each of the analyzed models is smaller than 2%.

5.2.3 Testing hypothesis 3

The hypothesis 3 in this research is "Receiving public investment is a significant determinant of the perception of barriers to innovating with the public sector" To test this hypothesis, this study looks at the Pearson's correlation displayed in Table 8 and the Multiple OLS Regression displayed in Table 9.

In the case of Demand of innovation as barrier, Pearson's correlation displayed in table 8, shows that the correlation coefficient between the variable Public investment beneficiary and Demand of Innovation is -0,05 with an alpha level of 0.1, allowing to confirm that there is a statistical association between the two variables. Furthermore, looking at the Multiple OLS Regression in Table 9, the estimate of -0,006 suggests that there is a negative relationship between this two variables, which implies that being beneficiary of Public Investment decreases the perception of Demand of innovation as a barrier for public provider enterprises, as the p-value is lower than 0,1.

In the case of Finance management as barrier, Pearson's correlation displayed in table 8, shows that the correlation coefficient between Public investment beneficiary and Finance management is -0,1 with an alpha level of 0,01, allowing to confirm that there is a statistical association between the two variables. Furthermore, looking at the Multiple OLS Regression in Table 9, the estimate of -0,17 suggests that there is a negative relationship between this two variables, which implies that being a Public investment beneficiary decreases the perception of Finance management as a barrier for public provider enterprises, as the p-value is lower than 0,01.

In the case of IPR management as barrier, Pearson's correlation displayed in Table 8 determined that Public investment beneficiary does not reach significance in its relationship with IPR management

as a barrier. This same situation happens when looking at the Multiple OLS Regression in Table 9. The variable Public investment beneficiary does not reach significance when evaluating its relationship with IPR management.

In the case of Risk management as barrier, Pearson's correlation displayed in Table 8 determined that Public investment beneficiary does not reach significance in its relationship with Risk management as a barrier. This same situation happens when looking at the Multiple OLS Regression in Table 9. The variable Public investment beneficiary does not reach significance when evaluating its relationship with Risk management.

The conducted Pearson's correlation procedure allows this study to confirm that the variable Public investment beneficiary holds a statistically significant correlation with the barriers of innovation (except IPR management and Risk management). Moreover, the Multiple OLS Regression allows to confirm that there is a relationship between Public investment beneficiary and the barriers to innovate (except IPR management and Risk management) which is negative and statistically significant.

5.2.4 Testing hypothesis 4

The hypothesis 4 in this research is "Access to information moderates the relationship between the public sector providers (size of the enterprises, the R&D investor enterprises, public investment beneficiaries) and the perception of barriers to innovation". This hypothesis can be divided in multiple sub-hypothesis, therefore, the analysis of each interaction will be conducted in the following paragraphs.

The results of testing the moderator role of Access to Information in the model can be found in Table 9, where the Model 2 is displayed. As it is shown in, the R^2 values in Model 2 are evidently larger compared to every R^2 values found in Model 1.

In the case of dependent variable, Demand of Innovation as the first barrier, the moderator role of Access to Information was tested for the independent variables Size of the enterprise, R&D investment and Public Investment beneficiary (Logsize*Info, RD*Info, PI*Info). This study found that,

in the presence of Information as a moderator, the relationship between Size and Demand of Innovation, R&D investment and Demand of innovation and Public Investment beneficiary and Demand of innovation, are significant at an alpha level of 0,01, 0,05 and 0,1 respectively.

In the case of dependent variable, Finance management as the second barrier, the moderator role of Information was tested for the independent variables Size of the enterprise, R&D investment and Public Investment beneficiary (Logsize*Info, RD*Info, PI*Info). This study found that, in the presence of Information as a moderator, only the relationship between Size and Finance management is significant at an alpha level of 0,01. This is not the case of R&D investment and Public Investment Beneficiary where the moderator role of Information was not significant.

In the case of dependent variable, IPR management as the third barrier, the moderator role of Information was tested for the independent variables Size of the enterprise, R&D investment and Public Investment beneficiary (Logsize*Info, RD*Info, PI*Info). This study found that, in the presence of Information as a moderator, the relationship between Size and IPR management, and Public Investment beneficiary and IPR management, are significant at an alpha level of 0,01 and 0,05 respectively. This is not the case of R&D investment where the moderator role of Information was not significant.

In the case of dependent variable, Risk management as the first barrier, the moderator role of Information was tested for the independent variables Size of the enterprise, R&D investment and Public Investment beneficiary (Logsize*Info, RD*Info, PI*Info). This study found that, in the presence of Information as a moderator, the relationship between Size and Risk management, R&D investment and Risk management and Size and Risk management, are significant at an alpha level of 0,01, 0,05 and 0,5 respectively.

Finally, this study found that the Information as moderator of the relationship between the determinants and the barriers of innovating with the public sector, is satisfactory for the majority of the cases tested. The fitness of the model increased, as it can be evidenced in the R^2 row in Table 9, comparing Model 1 (without moderator variable/ Demand of Innov: 1,3%, Finance Managm: 1,3%, IPR: 0,7% and Risk 0,4%) and Model 2 (with moderator variable/ Demand of Innov: 26%, Finance

Managm: 10%, IPR: 15% and Risk 29%)

5.3 Discussion

This study looks from the perspective of private enterprises to assess the barriers to innovate with the public sector. Digging into the barriers, this research formulates two models and conducts several statistical procedures to assess the determinants of those barriers analyzing the characteristics of the enterprises who provide services to the public sector.

1. Descriptive analysis

In the descriptive analysis section of chapter 5, this research described the characteristics of the sampled enterprises. There are three factors about the characteristics of the sample worthy to mention in this section, found in Table 4. First, 72% of the enterprises reported zero investment in R&D activities in the previous year, representing the low culture of innovation in the service sector.

Second, the Human Resources Quality classification shows that 37%, about 462 enterprises of the service sector enterprises in this sample reported less than 25% of high qualified personnel, while only 13% of the enterprises have 75% or more of their employees highly qualified, about 165 enterprises.

Third, the majority of the sampled enterprises have between 50 and 250 employees, giving a relevant representation to SME's in this study, accounting for 596 enterprises out of 1.292

2. Empirical analysis: Digging into the barriers to innovate with Colombian public sector

After defining the barriers to innovation based in the thorough Literature Review, this research studied only the public sector providers (N=1.296) through model 1 and 2 and proceeded with two statistical procedures; Pearson's Correlation and a Multiple OLS Regression. A comparison of relevant findings is discussed below.

In the case of demand of innovation, the theory suggests that the smaller the enterprise the more intense this barrier would be perceived (Uyarra et al., 2014), moreover, the level of investment on R&D

and receiving Public Investment decreases its perception (Corchuelo & Carvalho, 2013), (Fundación Suiza de Cooperación para el Desarrollo Técnico, 2020).

The empirical study tested through Pearson's correlation and a Multiple OLS Regression, found a statistical association and a negative relationship between R&D level of investment and being Public Investment beneficiary, meaning that this two characteristics of the enterprise can mitigate the perception of demand of innovation. Moreover, testing Model 2 with the moderator effect of Access to Information, this study found statistical significance in every independent variable including Size of the enterprise, R&D Investment and Public Investment beneficiary, in addition, the R^2 is higher in Model 2 (including moderator variable) compared to model 1, meaning that the fitness of the model increases in the presence of the moderator variable.

In the case of finance management, the theory suggests that the smaller the enterprise the more intense this barrier would be perceived (Suárez-González & Galende, 1998) due to financial limitations.

The empirical study tested through Pearson's correlation and a Multiple OLS Regression, found a statistical association and a negative relationship only for Public Investment beneficiaries, meaning that receiving resources Public Investment can mitigate the perception of finance management as a barrier. Moreover, testing Model 2 with the moderator effect of Access to Information, this study found statistical significance only in its interaction with the Size of the enterprise, however, the R^2 is higher in Model 2 (including moderator variable) compared to model 1, meaning that the fitness of the model increases in the presence of the moderator variable.

In the case of IPR management, the theory suggests countries with a defined policy to grant the protection of Intellectual Property Rights, leads to enhances the private investment on R&D (Varsakelis, 2000), moreover (Suárez-González & Galende, 1998) suggests that the larger the enterprise more intense this barrier would be perceived (Suárez-González & Galende, 1998).

The empirical study tested through Pearson's correlation and a Multiple OLS Regression, didn't find any statistical association with the perception of IPR management as a barrier. However, testing

Model 2 with the moderator effect of Access to Information, this study found statistical significance in its interaction with the Size of the enterprise and the Public Investment beneficiary, moreover, the R^2 is higher in Model 2 compared to model 1, meaning that the fitness of the model increases in the presence of the moderator variable.

In the case of Risk management, this study tested through Pearson's correlation and a Multiple OLS Regression, finding relationship only for R&D investment, meaning that investing in R&D can mitigate the perception of this barrier. Moreover, testing Model 2 with the moderator effect of Access to Information, this study found statistical significance in every independent variable including Size of the enterprise, R&D Investment and Public Investment beneficiary, in addition, the R^2 is higher in Model 2 compared to Model 1, meaning that the fitness of the model increases in the presence of the moderator variable.

Finally the model without the moderator role of Access to Information cannot predict efficiently the barriers to innovating with the public sector by its own, however, in the presence of Access to Information as a moderator variable, this study is able see effect on each dependent variable with clarity.

Chapter 6. Conclusions

This chapter will attempt to answer the two research questions formulated in the beginning of the investigation, which includes the empirical findings and the implications. The last part will present the limitations of the research.

This research attempt to answer two questions; RQ1. What are the barriers to innovating with the Colombian public sector from the service supplier's perspective? And RQ2. What measures and mechanisms should be applied to correct the perceived barriers? The answers are the following.

For RQ1, this study conducted a thorough literature review to assess the barriers to innovating with Colombian public sector, which took place in chapter two. Four barriers were defined including Demand of innovation, financial management, IPR management and Risk management. To assess the determinants of these barriers, empirical procedures were conducted in chapter 4 and 5.

In the framework review conducted in chapter 2 it is shown that several studies have been conducted with similar approaches, most of them assessing barriers on the private sector (Suárez-González & Galende, 1998; Corchuelo & Carvalho, 2013) or in the public sector but with the perspective of public procurers (DNP, 2020; Uyarra et al., 2014). However, this study differentiates from them as it tries to evaluate the perspective of providers of the public sector as only source of information.

1. Conclusions:

First, studying only the sample of public sector providers, this research can conclude that the size of the enterprise has significance to determine the level of perception of the barriers, only in the presence of Access to Information as moderator in the model.

Second, the investment on R&D by public sector providers, has significance and negative correlation with the Demand of Innovation and Risk management, meaning that the more investment in R&D activities, the lower the perception of this barriers. This is not the case of the barriers Finance

management and IPR management. Moreover, the moderator role of Access to Information is significant in the case of the two barriers, meaning that it alters the effect on both side of the equation. Certainty, information about opportunities or public instruments can enhance the private investment on R&D and at the same time lower the perception of the mentioned barriers.

Third, the variable Public Investment, has significance and negative correlation only with financial management, meaning that public sector providers that received public investment, have a lower perception of this barrier. The other barriers to innovation such as Demand of innovation IPR management and Risk management does not hold any significance. However, the moderator role of Access to Information is significant in the case of all the barriers, meaning that it alters the effect on both side of the equation, the independent and the dependent. It is obvious that having information about public instruments can enhance the reception of Public Investment and at the same time lower the perception of all the barriers to innovate.

2. Recommendations:

To answer RQ2, this research builds upon the conclusions section and the Colombian case analysis, including the analysis of other countries experiences. The recommendations can be summarized in two key points.

First, one of most prominent findings of this study is important role of Access to Information in the independent variables (Size, R&D investment and PI) and the level of perception of barriers to innovating with the public sector. This research recommend to build an ecosystem of innovation that guarantee the free circulation of information. Following the strategy of UK, (Edler, 2016), every Colombian public agency should publish and make clear the tenders and opportunities that yearly require innovative solutions or improvements, this action does not imply investment of resources but it can contributes to reduce uncertainty, This type of instruments have been labeled as Innovation Procurement Plans, made public for the private sector to consult, and the Forward Commitment Procurement, which ensures future investments to allow the development of innovation on early stages.

Second, designing public policies of innovation that focus on each classification of enterprise size that enhances investment in R&D can help to reduce the perception of this barriers and therefore, enhance the production of innovation. Public policies of innovation such as Public Procurement of Innovation and Pre-Commercial Procurement have this flexibility required to tackle this barriers. Although this type of policies started to gain popularity very recently in Colombia, due to the decree 442 of 2022 of the National Planning Department, its implementation should take into account important factors as the size of the enterprise and the investment on R&D activities.

3. Limitations of the study

This study finds limitations in the stance of not getting enough specificity about the Colombian case. Although the data used is gathered from a survey applied to Colombian enterprises, the specificity about barriers can be better assessed through interviews and a more qualitative analysis.

The characteristics of the enterprise can include other variables that can depend on the sector analyzed. This study decided to analyze the most relevant, theory based variables, however it should be said that other variables can be included and find significance as well.

Finally, the conclusions of this study can be applied to the Service sector in a general view, however, there can be found some specific dynamics in subsectors that may be ignored by the present study.

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Abstract in Korean

콜롬비아 공공부문과의 혁신 장벽: 서비스 부문 공급자의 관점

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혁신은 더 이상 선택이 아닌 개발의 필수 요소이다. 본 연구는 콜롬비아 공공부문의 혁신 장벽을 경험적 방법을 통해 평가하고, 민간부문의 미개척 관점을 제공하며, 나아가 다른 나라들의 경험을 활용하여 결정된 장벽을 시정하기 위한 정책 제언을 최종적으로 제시할 때까지 장벽의 결정요인을 연구할 것이다.

본 연구는 전반기 조사에서 민간 및 공공부문과 함께 혁신장벽에 대한 광범위한 문헌고찰을 수행하고, 수요측면 혁신정책 채택에 대한 타국의 경험을 분석하는 섹션을 제공한다.

본 연구는 서비스 분야의 혁신에 초점을 맞춘 국가통계국(EDTX)이 매년 실시하는 설문조사를 실증적인 부분인 후반부에 활용한다. 다중 OLS 회귀 분석을 통해, 이 섹션은 제안된 혁신 장벽, 예를 들어 혁신 수요, 재무 관리, IPR 관리 및 리스크 관리, 문헌 검토 결과를 테스트하고, 기업의 규모, 연구개발 투자 수준 및 공공 투자의 수용이 조정자 변수로 정보가 있는 경우 세 가지 중요한 결정 요인이라는 결론을 내린다.

마지막으로, 본 연구는 확인된 장벽을 극복하기 위해 첫째, 행위자 간 정보의 자유로운 유통을 보장하기 위해 혁신 생태계를 강화할 것을 권고한다. 둘째, 콜롬비아는 기업 규모를 고려한 혁신 공공정책을 설계해야 하고, 특히 R&D 투자를 강화해야 하며, 본 연구는 이 권고안을 달성하기 위해 혁신 공공조달의 유연성을 탐색할 것을 제안한다.

키워드: 혁신 공공 조달, 혁신 정책, 수요 측 정책, 혁신 생태계, 조달.
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