POLITECNICO DI TORINO

Master of Science in Engineering and Management

An econometric analysis of the innovation financing in the manufacturing industry in Colombia 2017-2018

Supervisor:
Elisa Ughetto

Candidate:
Leidy Rodriguez

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This thesis is dedicated to:
First, I would like to thank God, for allowing me to study in a wonderful country like Italy and giving me the opportunity to learn so much throughout my master's degree. Thanks to my parents, brother and grandmother, who with their love and effort have allowed me to reach another goal, thank you for showing me the importance of education, for instilling in me the desire to improve myself day after day, and for teaching me not to be afraid of adversities because God is always with me.

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ABSTRACT

The present paper presents a general view of statistical data coming from the investments in innovation made by Colombian companies and the way they are financed. After literature review, the Survey of Development and Technological Innovation of the Manufacturing Industry (EDIT IX) prepared by the National Administrative Department of Statistics – DANE was used to extract the companies' information and to analyze it through statistical graphics. Then, an econometric analysis was carried out by using statistical software R with the purpose of defining how the investment from own resources was associated with other variables. The main findings were: i) Own resources were the main source to finance innovation with a relative importance of 81.41% ii) The most of investments in innovation were represented by Machinery and equipment with 54.12% and iii) A regression model can explain the way the firms finance their investments. Finally, some recommendations were: i) to include other variables of interest in databases related to the age of the firms and their stage of lifecycle, ii) to consider macroeconomic aspects in future research and iii) to promote proper public policies that encourage the innovation in Colombia.

INTRODUCTION

Over time, innovation has been considered as a critical factor of the firm and economic development of countries, also is in charge of establishing new paradigms and technological development (De Faria et. al, 2019). However, although there is evidence of its contribution to improving firms competitiveness and productivity, it is also important to highlight the existence of restrictions associated with obtaining the necessary funds to carry out this type of investment projects. For that reason, according to Wellalage, N. H., & Fernandez, V. (2019), there is a broader consensus that the funding types play a significant role in innovation.

There are few academic publications that relate the innovation activities carried out by Colombian firms and their respective financing (Arbeláez and Parra, 2011). However, Becerra (2001) stresses that innovation activities in Colombia present financing restrictions due to their great risk and the lack of physical assets that serve as collateral. These restrictions make it difficult to obtain financial resources, which happens more frequently in smaller firms.

When analyzing the evolution of investments in science, technology and innovation in Colombia, a slow dynamism is evident, a situation contrary to international trends and the needs of the country. Gómez, H. J., & Mitchell, D. (2014). However, in recent years, Colombia has discovered the importance of science, technology and innovation activities for progress and has allocated resources for this purpose, establishing institutions that improve access to finance for small and medium-sized enterprises, for example: SENA, COLCIENCIAS and BANCOLDEX. (Departamento Administrativo Nacional de Estadística, 2017-2018).

On the other hand, Salazar, J. C. (2003) states according to Bolsa de Valores de Colombia (2002) that in recent years, the progressive growing of pension and severance funds, of trust funds, securities funds, insurance companies and foreign capital funds (although with minimal participation) have driven the progress of the capital market in Colombia. However, the Capital Market Studies Mission characterized the Colombian capital market as small, not very liquid and highly concentrated (Ministerio de Hacienda, et al, 1996), a conclusion that was also obtained by the Consejo Privado de Competitividad (2007).

Likewise, Colombia promotes fiscal measures to encourage investment in Science, Technology and Innovation, particularly, tax incentives that are considered as resources that the state stops collecting by granting certain exemptions to research and technological development activities. In

the same way, Colombia has worked to promote the production of high-quality national statistical information related to innovation, through the processes of collection and analysis of the results of the Survey of Technological Development and Innovation in the manufacturing sector. (EDIT by DANE). The first measurement exercise of this type was carried out by the National Planning Department in 1996. In 2005, it was developed by the National Administrative Department of Statistics (DANE). In 2010, methodological improvements were introduced. In 2012, based on the observations of international experts and based on the guidelines of the Frascati Manual, some questions were added to increase the consistency of the information. To this improved collection instrument, the International Standard Industrial Classification - ISIC was added and this has been used to date. (DANE,2017)

However, the efforts made, and the amounts invested in STI activities by both the public and private sectors in Colombia have been insufficient. As evidenced by Barona-Zuluaga, B., & Rivera-Godoy, J. A. (2017) from CONPES (2016), investment in R&D in the country in 2015 amounted to 0.23% of GDP, a percentage that is well below countries such as Brazil, Argentina, and Mexico.

To evaluate financing, Salazar, J. C. (2003) from Pineda, L., (2002) affirms that it is necessary to consider the National Innovation System (SNI), which is the institutional framework in Colombia that encompasses the set of cooperation relationships of both public (ministries, decentralized entities and public banks) and private (Technological Development Centers, Regional Productivity Centers and business incubators) in the development and transfer of new technologies. Although innovative companies have resorted to internal sources and bank credit to carry out their operations, these companies consider that such sources have been insufficient to allow them to achieve a feasible development.

Among previous studies of the relationship between innovation and funding sources, the research by Sierra et al. (2009) and Arbeláez and Parra (2011), conclude that in Colombia larger companies are more innovative than smaller ones; argue that investment in R&D is negatively affected by foreign ownership of the company, that public financing is highly relevant for investment in innovation and that public instruments are effective promoters of total innovation; additionally, Zuluaga, B. B., et al. (2015) from Sierra et al (2009) indicates that the main reasons why smaller companies do not innovate is that they consider that "innovation is not profitable or unnecessary; also, although with less importance, they affirm not to do so due to lack of financial resources, which is supported by Otálora et al. (2009), who conclude that "entrepreneurs on average have little interest or aversion to knowing sources of financing". Finally, Zuluaga, B. B., et al. (2015) highlight the prevalence of own resources and those provided by private banks, which coincides with the results of Sierra et al. (2009) and Barona et al. (2014); in the same way, they evaluate public financing mechanisms and find that, among these, the most used is Bancoldex. In addition, Cohen and Levin (1989) reveal that in the case of large companies, a clear preference for internal financing over external financing is evident, to the extent that these companies have a greater capacity to generate resources to finance their innovations. For their part, Zuluaga, B. B., et al. (2015) from the research of Langebaek and Vásquez (2007), which analyze the determinants of innovation in the Colombian manufacturing industry, found that this activity shows a strong relationship with the size of the company and the presence of foreign capital in the property.

In this order of ideas, the purpose of this document is to contribute to the knowledge that currently exists on the innovation activities carried out by private companies in Colombia, and the way in which this investment is financed. Given the importance of innovation for countries transformation, this thesis develops an econometric analysis using as source of information the Survey of Innovation and Technological Development in the Colombian manufacturing industry (EDIT IX), prepared by the National Administrative Department of Statistics (DANE), with data from technological development and innovation activities carried out by manufacturing companies for the years 2017 and 2018.

Theis thesis consists of five chapters: the first one presents the literature review about fundamentals of innovation financing emphasizing the Colombian case and theory about the statistical tools that will be used; the second one exhibits the methodology for collecting and interpreting the data, the third one stresses the main results and contrast them with theorical developments, the fourth one is based on conclusions and the last one indicates some recommendations.

CONTENTS

1. THEORETICAL FRAMEWORK

1.1. Innovation financing

This document is framed within economic theory, the which has identified innovation as one of the determining factors of economic development according to Barona-Zuluaga, B., et al. (2015) from Schumpeter (2008). The innovation is closely linked to continuous improvement and choosing its best source of financing is an important issue that has not an accurate and/or a single solution. There are several concepts of innovation that will be detailed below:

- ✓ Porter (1990) conceives business innovation as "a new way of doing things that are marketed". It means that there are ideas, knowledge, technologies, and products in continuous transformation. Then, the purpose is to discover and invent other waysof reaching new knowledge, perfecting technologies, and transforming or creating new highly competitive products.

- ✓ The Oslo Manual (OECD, 2005) defines innovation as the introduction of a new, or significantly improved, product, service, process, organizational method. It also differentiates between product, process, marketing, and organizational innovations:
  - Product innovation consists of the creation of new products or services, or the improvement of the characteristics, benefits, and quality of existing ones.
  - Process innovation involves the introduction of new production methods or the modification of existing ones, and its main objective is cost reduction.
  - Marketing innovation is the application of a new marketing method that involves significant changes in the design or packaging of a product, its positioning, its promotion, or its pricing.
  - Organizational innovation is the introduction of a new organizational method in the practices, the organization of the workplace or the external relations of the company.

- ✓ Fayomi et al., (2019) define innovation as "the ability to continuously transform new knowledge and ideas into new products, processes and systems", and, according to Popa et al., (2010) state that "innovation has become an essential source of competitive advantage due to technological development and intense global product and service competition".

It is worth noting that any type of innovation involves high risks, since it is not possible to know the results (financial, technical and market-related) before making the investment. This is how the aversion to risk of the actors involved in the process could become an obstacle on innovation activities. In an ideal world, companies would sell products or services and use the proceeds to finance new products and services. However, risk aversion means that companies do not use the profits to finance innovation, preferring to give dividends to shareholders or save profits for possible eventualities. This is how external funders come into play to finance innovation.

On the other hand, innovation is a process driven by competition in the market, since companies are incentivized to outperform each other. For this reason, companies are forced to strengthen and invest on their innovation activities if they want to be successful in the economy where they are operating. In this way, it is also important to highlight the role of appropriability regimes, which allow the proponents of innovations to save their economic value without having to share it with other actors; and in turn, they serve as an incentive for the creation of new knowledge.

Innovation contributes to economic development, since it generates higher levels of productivity, favors the generation of employment and the satisfaction of social and environmental needs. For this reason, companies see innovation as a driver of competitive advantage. In this sense, organizations must carry out innovation activities, in order to generate new products and processes and acquire greater flexibility in the face of change.

However, countries do not have the same capacity to finance innovation, particularly for Science, Technology, and Innovation (STI) activities. Sierra (2019) states that even though Colombia is positioned as the fourth largest economy in Latin America, it spends only 0.25% of GDP on STI, 30% of which comes from the government, the other 70% comes from private financing. This situation is caused because Colombian companies adopt the preference for financing innovation in hierarchical order: first, resorting to their own resources, then banks and finally, public operations, since they only resort to external sources of financing when profits are exhausted, which means that companies assume all the risk of innovation, for this reason innovation and therefore economic growth are hindered. This is how in Colombia there seems to be a conflict around innovation, as companies do not invest enough in innovation, but when they do, they prefer to use internal financing and in cases of low liquidity, companies look for expensive bank loans instead of cheaper government support.

Sierra (2019) states that two theories prevail within the financing of innovation:

- ✓ **The trade-off theory** also known as static theory, suggests that companies adapt to an optimal level of indebtedness, which is determined by a trade-off between the costs and the benefits of indebtedness, that is, the level of indebtedness depends on an optimal balance between the tax advantages of the debt and the disadvantages derived from the increased possibility of bankruptcy. When the optimal combination of debt

and equity is reached, companies maximize their value and have no incentive to increase their debt, since an additional monetary unit in debt implies a net marginal loss of that value. Therefore, this theory defends the existence of an optimal capital structure in the company, considering that such structure defines the value of the firm.

- ✓ **Pecking Order Theory (POT):** affirms that there is no optimal capital structure but rather, when companies make new investments, they first resort to financing with internal funds because the costs and risks are low and there is no information asymmetry, then they resort to debt (which is cheaper than equity because agency costs raise the risk of equity funding) and as a last option to issue shares since companies are aware of the asymmetry of information in the capital market. In this regard, Zambrano and Acuña (2011. p.95) state: "The Pecking Order today has great acceptance since there are many organizations in our environment that do not seek the optimal combination between debt and capital but rather try at all times to finance their new projects with their own resources."

  At present this theory achieves great importance within organizations because most companies are not in search of an optimal combination but rather are trying to finance their new investments with their own resources due to their aversion to information asymmetry in the capital market.

Morales, E. A. M. (2019) according to Hall & Lerner (2009) states that the market failures are larger for innovative and high technology companies since innovation involves a higher risk and its duration is longer than traditional capital investments. Then, it entails a higher profit rate required by external investors, which drives the use of internal funding. This idea is supported by Manigart & Struyf (1997) who concluded that Belgium high technology firms, follow POT parameters. This is the same case for Italian high technology companies, which according to a study of Bartolini (2013), their main source of financing for innovation is own resources.

The use of the POT theory in Colombia is given two different points of view: Morales, E. A. M. (2019) state that in a developing country like Colombia, innovative firms will tend to fund their innovation activities according to POT Theory, and, if internal funding is not enough, firms will have to look for external sources of financing, being debt preferred to equity, since Colombia is characterized by a small, illiquid and difficult to access equity market. But, on the other hand, Sierra (2019) stresses that Colombian companies do not follow a standard practice of the POT theory for the financing of innovation, since according to Manigart & Struyf (1997) and Giudici & Paleari (2000), this transaction not only depends on the risks and costs but also depends on the nature of the project, on the characteristics of the company and the funders. It is supported by García, D., et al. (2013) who evidence in their research that the existence of a positive relationship between the size of the company and the performance of innovative activities has been identified.

On the other hand, Barona, B., et al. (2017) affirm that modern financial economic theory indicates that the characteristics of investment in innovation are a key element to understand the way in which innovation activities should be financed. This is how a very precise estimate of the future cash flows that the activities to be financed will generate is required to decide which investment activities to finance. They also conclude from Arbeláez and Parra (2011) research that large and medium-sizedcompanies innovate more intensively than small firms, find that investment in R&D is negatively affected by foreign ownership of the company, and lastly, they affirm that public financing is highly relevant for investment in innovation. and that public instruments are effective promoters of total innovation.

Based on an analysis of the innovation activities of SMEs in 47 developing economies, Barona, B., et al. (2017) according to Ayyagari et al., (2011) conclude that bank financing (domestic and foreign private banking) was positively associated with the improvement of existing products lines, the opening of a new plant and the signing of joint ventures with foreign partners.

Other important aspect highlighted by Zuluaga et al. (2015) from Arrow (1962) is that companies tend to make less investment in innovation than is considered optimal for achieving high levels of economic growth development. One reason worth noting according to Zuluaga et al. (2015) is that a very high percentage of investment in innovation is represented in remuneration of highly qualified personnel, such as scientists and engineers. Although conceptually these payments constitute an investment for the company, due to their intangible nature it is an investment very different from the investment in physical assets such as inventory in merchandise or plant and equipment.

1.2. Innovation classification

In order to obtain a better understanding of the procedures carried out in this document, it is important to provide the companies classification according to the progress made in terms of innovation results, which is defined by EDIT IX (DANE, 2017-2018):

- ✓ **Innovative in the strict sense:** companies that obtained at least one service, either new or significantly improved in the international market.

- ✓ **Innovative in a broad sense:** companies that obtained at least one service either new or significantly improved in the national market or a new or improved service for the company, or that implemented a new or significantly

improved production process improved for the main production line or for complementary production lines or a new organizational or marketing form.

- ✓ **Potentially innovative:** companies that have not obtained any innovation, but that they reported having an innovation project in process or having abandoned, either to obtain a new or significantly improved product in the international market, in the national market, or for the company; or to obtain a production process for the main production line or for complementary lines, or a new organizational or marketing technique.

- ✓ **Non-innovative:** companies that did not obtain innovations, nor did they report having in process, or having abandoned, any project to obtain innovations.

1.3. Econometric analysis

Given the importance of the econometric techniques in providing instruments to the economist for him to carry out economic studies considering statistical data and considering the elements that compose it, it is necessary to define what econometry is.

Econometrics is a branch of economics that uses statistical methods to study and quantify economic phenomena through real data, thus providing clues about the relevance of scientific theories developed by economists (Ventosa, 2012). This means that econometry is a science that allows the estimation of economic relationships. Therefore, this scientific discipline can, based on certain data, test hypotheses and finally forecast the behavior of both economic and individual variables.

Now, according to (López, et al. 1986) an econometric analysis has the main objective of explaining one variable in terms of others and it follows the subsequent steps:

- ✓ Statement of the theory
- ✓ Specification of the econometric model
- ✓ Estimation of the parameters of the chosen model
- ✓ Statistical verification or inference
- ✓ Predictions or forecasts

From this, it is necessary to define what a regression model is.

A tool that will allow us to analyze the relationship between the type of resources that companies invest in innovation and other variables is a *Multiple Regression Model*. To understand how this works, it is important to define what is a *Simple Regression Model.*

Simple Regression Model is a statistical technique that allows us to predict the relationship between two variables: the predictor variable (x) and the response or results variable (y).

This model has the following expression:

$$y = \alpha + \beta X + \varepsilon \quad (1)$$

Where α is the ordinate at the origin (the value that Y takes when X is equal to 0), β is the slope of the line (and indicates how Y changes when X increases by one unit) and ε a variable that includes a large set of factors, each of which influences the response only to a small extent, which we will call error. X and Y are random variables, so an exact linear relationship cannot be established between them.

- ✓ In this way, Rodrigo, J. A., (2016) states that a *Multiple Regression Model* is an extension of simple regression model and allows generating a model in which the value of the dependent variable or response (Y) is determined from a set of independent variables called predictors.

General form of a multiple model is shown as follows:

$$y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_i X_i + \varepsilon \, (2)$$

The terms β_0, β_1, β_2, β_i are called regression coefficients and Rodrigo, J. A., (2016) defines them as follows:

β_0: is the ordinate at the origin, the value of the dependent variable Y when all predictors are zero.

βi: is the average effect of the increase in one unit of the predictor variable x_i on the dependent variable y, keeping the rest of the variables constant.

ε: is the residual or error, the difference between the observed value and that estimated by the model.

Predictor variables selection

When selecting predictors, Rodrigo, J. A., (2016) defines the method for this purpose:

- ✓ **Stepwise method:** uses mathematical criteria to decide which predictors contribute significantly to the model and in what order they are introduced. Within this method, two strategies are differentiated:

    - **Forward direction:** The initial model does not contain any predictors, only the parameter β_0. From this, singles variables are incorporated generating different models and the variables that are most statistically significant are selected. This process finishes until all variables that contribute to the model has been incorporated.

- **Backward direction:** The model starts with all the available variables included as predictors. Each variable that does not contribute to the model is eliminated one by one.

The step-by-step method requires some mathematical criteria to determine if the model improves or worsens with each incorporation or extraction. There are several parameters used, among which the AIC, BIC and adjusted R^2 stand out, each of them with advantages and disadvantages. They are defined below:

- ✓ $\boldsymbol{R^2}$ (coefficient of determination) is defined by Rousson and Goşoniu (2007) as a quantifier of the goodness of fit of the model. It allows to quantify how good the model is to predict the value of the observations. In multiple models, the more predictors included in the model, the greater the value of R^2, since, no matter how little, each predictor will explain a part of the variability observed in Y.

- ✓ **Adjusted $\boldsymbol{R^2}$** introduces a penalty to the value of R^2 for each predictor that is entered into the model. The value of the penalty depends on the number of predictors used and the size of the sample, that is, the number of degrees of freedom. The larger the sample size, the more predictors can be incorporated into the model. Adjusted R^2 makes it possible to find the best model, the one that manages to better explain the variability of Y with the least number of predictors. (Rodrigo, J. A., 2016).

- ✓ **The Akaike Information Criterion (AIC)** is a mathematical method that allows to evaluate how well a model fits the data from which it was generated. AIC is used to make a comparison between different models and determine which one best fits the data. (Ingdal, M., Johnsen, R., & Harrington, D. A., 2019).
- ✓ **The Bayesian information criterion (BIC)** or Schwarz criterion is a method that focuses on the sum of the squares of the residuals to find the number of lagged periods p that minimize this model. In other words, we want to find the minimum number of lagged periods that we include in the autoregression to help us with the prediction of the dependent variable. In this way, we will have control over the number of lagged periods p that we are including in the regression. When we exceed this optimal level, the Schwarz model will stop decreasing and therefore we will have reached the minimum. That is, we will have reached the number of lagged periods p that minimize the Schwarz model. (Neath, A. A., & Cavanaugh, J. E., 2012)

On the other hand, it is common to find cases in which the selection of predictors is based on the p-value associated with each one. Brereton (2019) defines the *p-value* as the probability, under the assumption of no effect or no difference (the null hypothesis), of obtaining a result equal to or more extreme than what was actually observed. Then, the idea is to remove the variables with a higher p-value than an established significance level.

The level of significance of a test is a statistical concept associated with the verification of a statistical hypothesis. In short, it is defined as the probability of making the decision to reject the null hypothesis (H_0) when it is true (a decision known as Type I Error).

Osborne and Waters (2002) raises four assumptions that allow validating the model:

- ✓ **Normal distribution of the residuals:** The residuals must be normally distributed with zero mean. To verify this, histograms, normal quantiles or normalityhypothesis tests are used.

  Different tests are used to check if the data of the dependent variable follow a normal distribution:

  - Shapiro-Wilk normality Test:
  - Jarque Bera Test
  - Anderson-Darling normality Test

  Also, there are graphical tools that allow to observe the behavior of the data and to conclude the presence of normality:

  - Boxplot
  - Histogram
  - Q-Q (quantile-quantile) plot

- ✓ **Constant variance of the residuals (homoscedasticity):** The variance of the residuals must be constant throughout the range of observations. To check this, the residuals are represented. If the variance is constant, they are distributed randomly, maintaining the same dispersion and without any specific pattern. An important tool to conclude homocedasticity is the Breusch-Pagan test and some of the most important graphical techniques to observe the behavior of data and to determine constant variance are:

  - Fitted values vs. Residuals
  - Response variable vs. Residuals

- ✓ **No autocorrelation (Independence):** The values of each observation are independent of the others, this is especially important to check when working with temporal measurements. It is recommended to represent the residuals ordered according to the recording time of the observations, if there is a certain pattern there are indications of autocorrelation. In this case, the Durbin-Watson hypothesis test and Partial Autocorrelation Function (PACF) plot can be used to determine data Independence.

- ✓ **Non-multicollinearity:** means that that there is no linear relationship between the regressors. According to Daoud (2017) the most recommended technique to evaluate coliniality is Variance Inflation Factor (VIF). The variance inflation factor (VIF) is a measure of the amount of multicollinearity in a set of multiple regression variables. Mathematically, the VIF for a regression model variable is equal to the ratio of the overall variance of the model to the variance of a model that includes only that single independent variable. This relationship is calculated for each independent variable. a high VIF indicates that the associated independent variable is highly collinear with the other variables in the model. The reference limits that are commonly used are shown in Table 1:

Table 1. VIF interpretation

VIF- value	Conclusion
VIF=1	Not correlated
1<VIF≤5	Moderately correlated
VIF>5	Highly correlated

2. METHODOLOGY

2.1. Companies' characteristics

The source of information used in this study was the Survey of Development and Technological Innovation of the Manufacturing Industry (EDIT) prepared by DANE (the most recent at the time of presenting this research project was EDIT IX, which covers the period 2017-2018). (See A1. EDIT Questionnaire).

EDIT IX is a survey that is consistent with the guidelines of the European Community Innovation Survey; however, EDIT contains a specific chapter in which companies are asked about the sources they use to finance innovation activities. Such a survey presents information from 8.062 firms of the directory of the Annual Manufacturing Survey of 2017, from which information was obtained from 7,529, since the other companies presented news, among them: change of economic activity, liquidation, and absorption. Table 2 presents the distribution of the companies that responded to the survey by economic activity:

Table 2. Distribution of companies

Economic activity	Number of firms	Market share
Total	**7.529**	
Processing and preservation of meat and fish	174	2,3
Processing and preservation of fruits, legumes, vegetables and tubers	56	0,7
Manufacture of oils and fats	71	0,9
Manufacture of dairy products	137	1,8
Manufacture of mill products, starches and their derivatives	115	1,5
Manufacture of coffee products	57	0,8
Manufacture of sugar and panela	31	0,4
Manufacture of other food products	619	8,2
Preparation of prepared animal feed	50	0,7
Preparation of beverages	95	1,3
Spinning, weaving and finishing of textile products	103	1,4
Manufacture of other textile products	165	2,2
Clothing making	826	11,0
Manufacture of knitted and crocheted items	34	0,5
Tanning and retanning of leather and manufacture of travel items	87	1,2
Footwear manufacturing	248	3,3
Sawing, planing and impregnation of wood	46	0,6
Manufacture of sheets of wood for veneer, boards and panels	14	0,2
Manufacture of wooden parts and pieces	36	0,5
Manufacture of wooden containers	35	0,5
Manufacture of other wood products	20	0,3
Manufacture of paper and cardboard	125	1,7
Printing activities and related services	401	5,3
Coking, petroleum refining and fuel blending	54	0,7
Manufacture of basic chemicals and their products	139	1,8
Manufacture of synthetic and artificial fibers	6	0,1
Manufacture of rubber products	79	1,0
Manufacture of plastic products	567	7,5
Manufacture of glass and glass products	65	0,9
Manufacture of non-metallic mineral products	301	4,0
Basic industries of precious and non-ferrous metals	30	0,4
Manufacture of metal products for structural use	232	3,1
Manufacture of other fabricated metal products	359	4,8
Manufacture of computer, electronic and optical products	24	0,3
Manufacture of electrical appliances and equipment	180	2,4

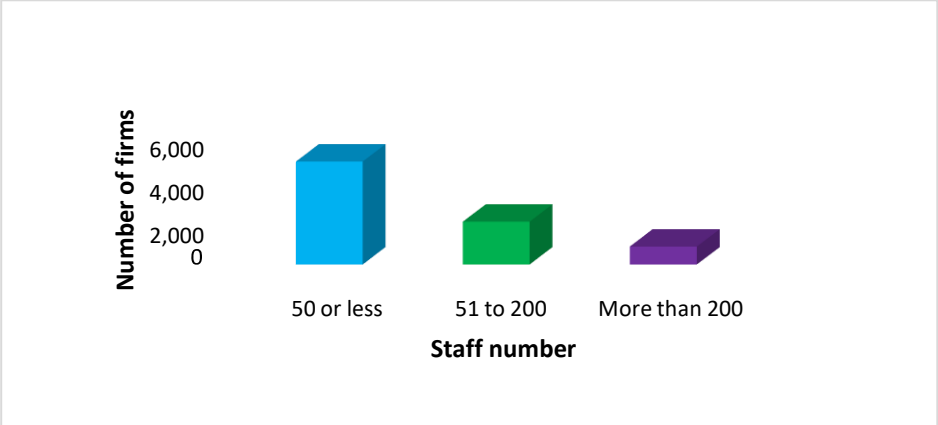
Manufacture of machinery and equipment for general use	199	2,6
Manufacture of machinery and equipment for special use	222	2,9
Manufacture of motor vehicles and their engines	12	0,2
Manufacture of bodies for motor vehicles	63	0,8
Manufacture of parts, pieces (auto parts) and accessories for vehicles	96	1,3
Manufacture of other types of transport equipment	33	0,4
Furniture manufacturing	344	4,6
Manufacture of mattresses and bed bases	39	0,5
Manufacture of jewelery, costume jewelery and related articles	20	0,3
Manufacture of articles and equipment for the practice of sport	12	0,2
Manufacture of games, toys and puzzles	24	0,3
Manufacture of medical and dental instruments, devices and materials	66	0,9
Other manufacturing industries	111	1,5
Maintenance and repair of metal products, machinery and equipment	32	0,4
Manufacture of pesticides and other chemicals for agricultural use	29	0,4
Manufacture of paints, varnishes and similar coatings	76	1,0
Manufacture of soaps and detergents, perfumes and toilet preparations	171	2,3
Manufacture of other chemicals	98	1,3
Manufacture of pharmaceuticals, medicinal chemicals	187	2,5
Basic Iron and Steel Industries - Metal Casting	114	1,5

Source: DANE, Technological Development and Innovation Survey – EDIT

For the period 2017-2018, the following classifications were analyzed:

-The scale of employed personnel: Figure 1 shows that 62.89% of the companies were made up of 50 or fewer people, while 26.15% of the total number of companies employed between 51 and 200 people and 10.96% of the companies were made up for more than 200 people. (See Data analysis Excel File- A.1. Sheet).

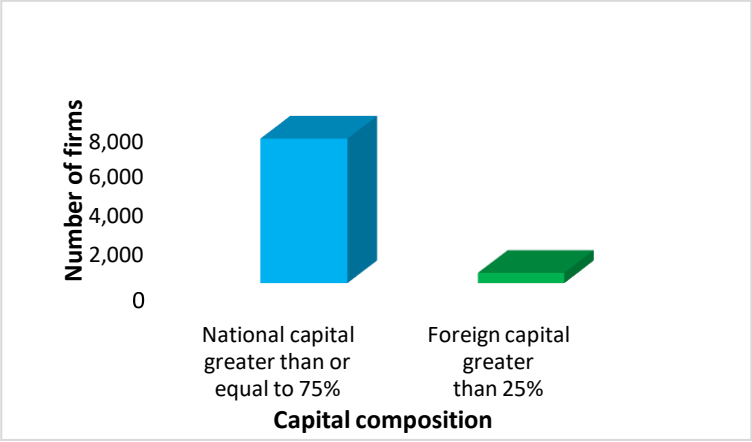
Figure 1. Distribution of manufacturing companies by scale of employed personnel



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

- Composition of capital: Figure 2 evidences that 93.35% of companies have national capital greater than or equal to 75% and 6.65% of companies with foreign capital greater than 25%. (See Data analysis Excel File - A.1 Sheet)

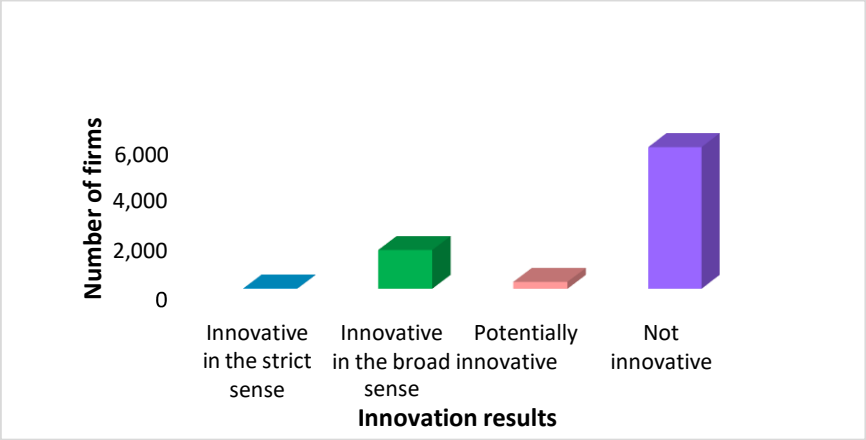
Figure 2. Distribution of manufacturing companies by capital composition



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

-Innovation results: Figure 3 allows us to observe that 0.00146% of the companies were innovative in the strict sense, 20.73% were innovative in the broad sense, 3.69% of the companies were potentially innovative and 75.43% were non-innovative. (See Dataanalysis Excel File - C.1.1 Sheet).

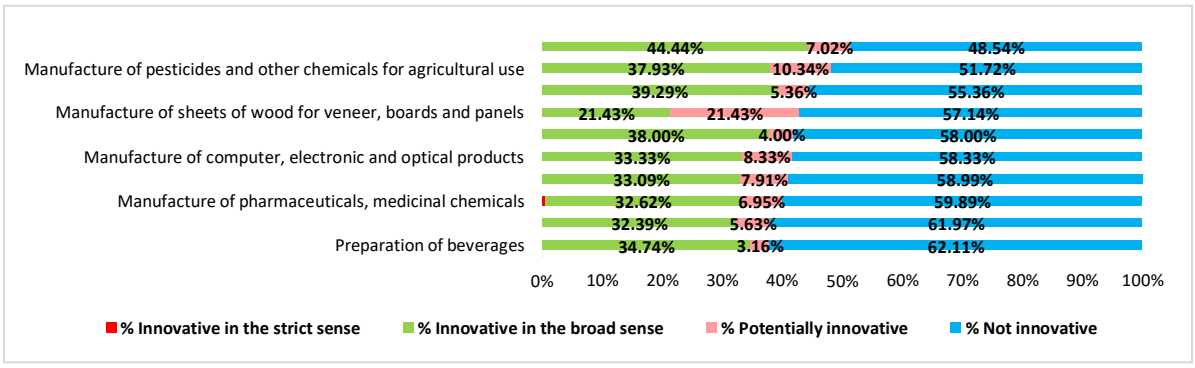
Figure 3. Distribution of manufacturing companies by innovation results.



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

Now, taking into account the industrial activities, *Coking, petroleum refining and fuel blending* presented the highest proportion of innovative companies in the strict sense, with 1.85% within its industrial activity; while the activities of *Manufacture of soaps and detergents, perfumes and toilet preparations* presented the highest proportion of innovative companies in a broad sense within its industrial subsector, with 44.44%. Finally, the activities related to *Manufacture of sheets of wood for veneer, boards and panels*, represented the highest proportion of potentially innovative companies, with 21.43% (See Data analysis-Excel File - C.1.1. Sheet). In Figure 4, the 10 most representative industrial activities in terms of degree of innovation are shown.

Figure 4. Distribution of industrial companies by typology defined in terms of innovation results



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

-Scope of diffusion: This classification is divided into three sub-classifications:

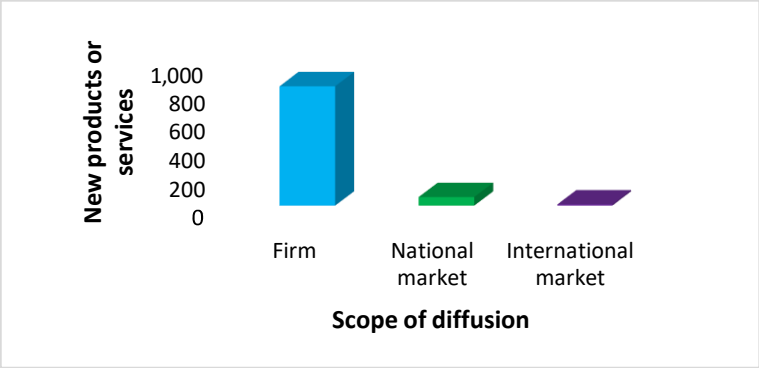
- ✓ Innovation of new final product (good or service).
- ✓ Innovation of final product (good or service) significantly improved.

- ✓ Innovation of business methods and / or techniques.

For the reference period, 430 companies made innovations in new products, 578 in significantly improved goods, and 1,298 in business methods and techniques.

- ✓ **Innovation of new final product (good or service):** Of the total innovations innew goods or services (889), 92.46% corresponds to innovations for the company, followed by 6.64% in new goods or services for the national market and finally, 0.90% represents the proportion of new product or service innovations in the international market. It is shown by Figure 5. (See Data analysis Excel File - C.1.2. Sheet)

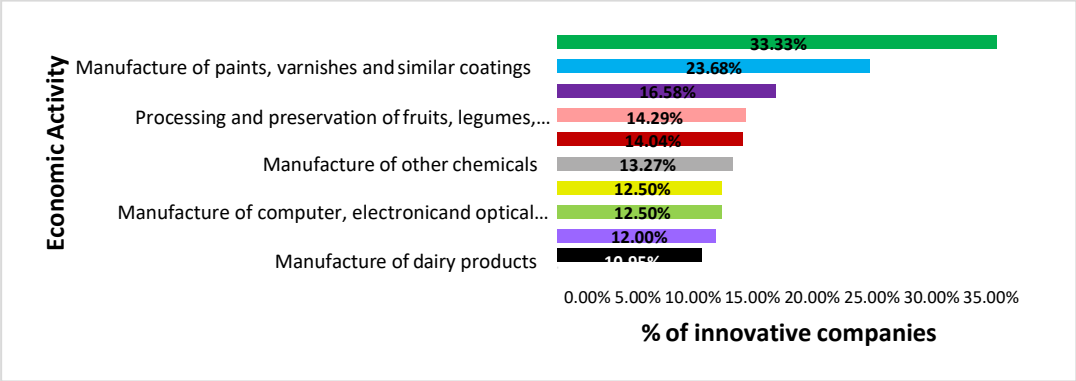
Figure 5. Distribution of industrial companies by diffusion scope of new product / service



Source: DANE, Technological Development and Innovation Survey – EDIT- Own creation

In Figure 6, the 10 most representative industrial activities in terms of percentage of innovative new product companies are shown. According to this graph, during the period 2017-2018, the activity of *Manufacture of synthetic and artificial fibers* registered the highest percentage of innovative companies for new products (goods or services), with 33,33% of all companies in this industrial activity, followed by *Manufacture of paints, varnishes and similar coatings* with 23,68% and the third place is for *Manufacture of pharmaceuticals and medicinal chemicals* with 16,58% of innovative companies for new products in this economic activity. (See Data analysis Excel File - C.1.2. Sheet)

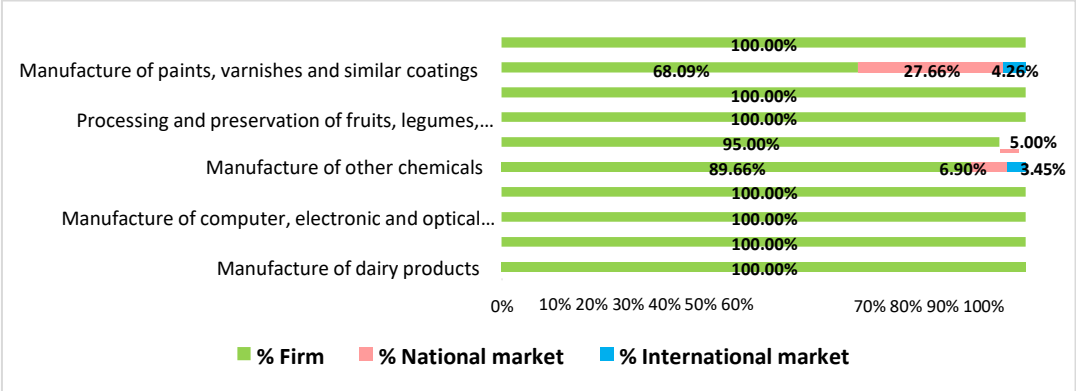
Figure 6. Percentage of innovative new product companies by industrial activity



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

According to the Figure 7, 100% of the *Manufacture of synthetic and artificial fibers* innovations were for the company, while 68.09% of the new product innovations of the *Manufacture of paints, varnishes and similar coatings* economic activity were for the company, 27.66% for the national market and 4.26% for the international market Finally, 100% of *Manufacture of pharmaceuticals and medicinal chemicals* innovations were for the company. (See Data analysis Excel File - C.1.2. Sheet)

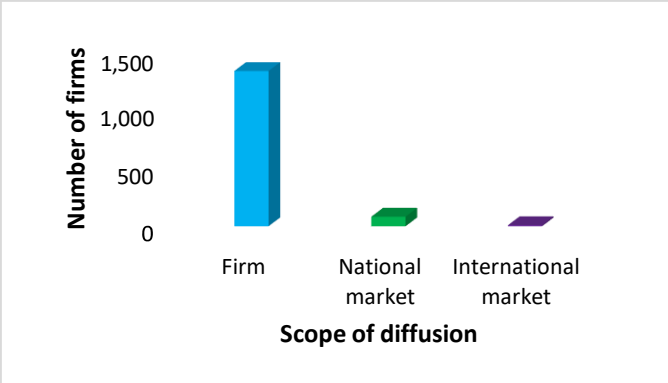
Figure 7. Distribution of new product / service innovations of industrial activities by level of scope



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

✓ **Innovation of final product (good or service) significantly improved**: On the other hand, looking at Figure 8, of the total of innovations in goods or services significantly improved (1427), 93.62% corresponds to innovations for the company, followed by 5.75% in innovations for the national market and finally, 0.63% represents the proportion of innovations in goods or services significantly improved for the international market. (See Data analysis Excel File - C.1.2. Sheet)

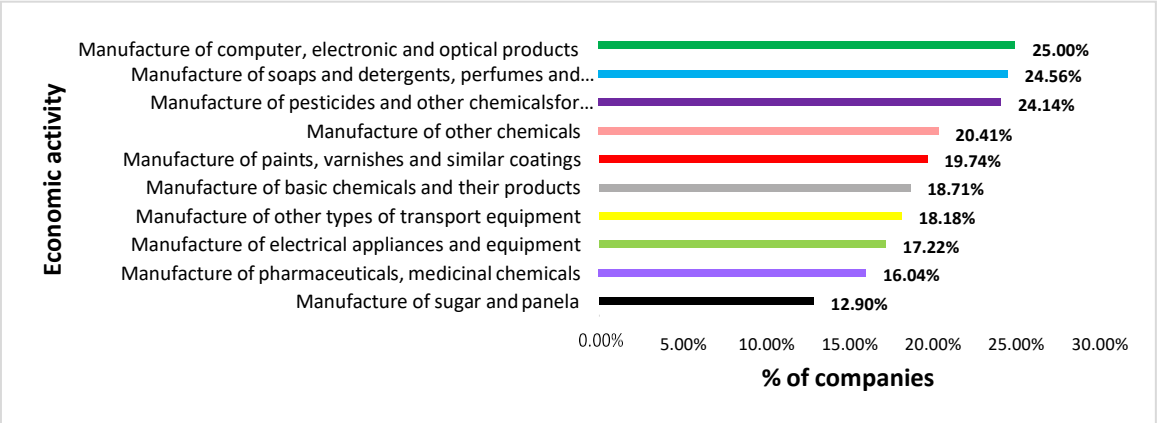
Figure 8. Distribution of industrial companies by diffusion scope of significantly improved products/services.



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

Figure 9 depicts the ten most representative industrial activities in terms of percentage of significantly improved product companies are shown. According to this graph, during the period 2017-2018, the activity of *Manufacture of computer, electronic and optical products* registered the highest percentage of significantly improved products (goods or services), with 25,00% of all companies in this industrial activity, followed by *Manufacture of soaps and detergents, perfumes and toilet preparations* with 24,56% and the third place is for *Manufacture of pesticides and other chemicals for agricultural use* with 24,14% of innovative companies for significantly improved products in this economic activity. (See Data analysis Excel File - C.1.2. sheet)

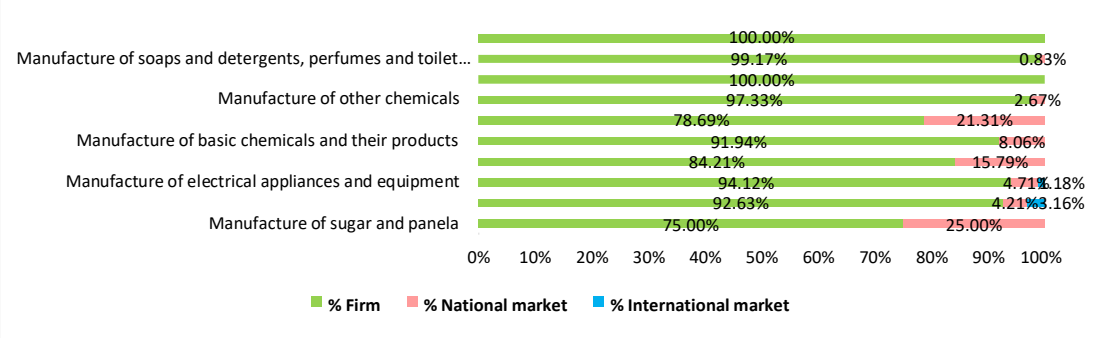
Figure 9. Percentage of significantly improved product companies by industrial activity



Source: DANE, Technological Development and Innovation Survey – EDIT- Own creation

Figure 10 shows that 100% of the *Manufacture of computer, electronic and optical products* improved products/services were for the company, while 99,17% of the innovations of the *Manufacture of soaps and detergents, perfumes and toilet preparations* economic activity were for the company and 0,83% internationalmarket Finally, 100% of *Manufacture of pesticides and other chemicals for agricultural use* innovations were for the company. (See Data analysis Excel File - C.1.2. Sheet)

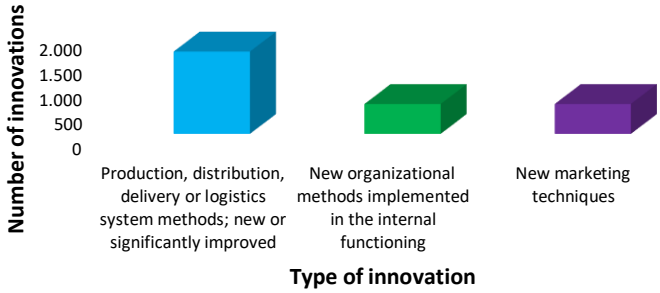
Figure 10. Distribution of significantly improved products/services of industrial activities by level of scope



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

- ✓ **Innovation of business methods and / or techniques:** Taking into account Figure 11, of the total number of business method and / or technique innovations made by industrial companies, 57.9% involved new methods of production, distribution, delivery or logistics systems, 21.1% of the total number of these innovations consisted of new marketing techniques and 21.0% in new organizational methods. (See Data analysis Excel File - C.1.2. sheet)

Figure 11. Distribution of method or technique innovations carried out by companies, by type of method.



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

Figure 12 depicts the 10 most representative industrial activities in terms of Innovative companies in business methods and / or techniques and it is possible to see that the *Manufacture of soaps and detergents, perfumes and toilet preparations* activity represents the highest percentage of innovative method and / or technical

companies, with 35.67% of all companies in its activity. In second place is the *Processing and preservation of fruits, legumes, vegetables and tubers* with 33,93% and in the third place, *Manufacture of synthetic and artificial fibers* with 33,33%. (See Data analysis Excel File - C.1.2. Sheet)

Figure 12. Percentage of Innovative companies in business methods and / or techniques by industrial activity

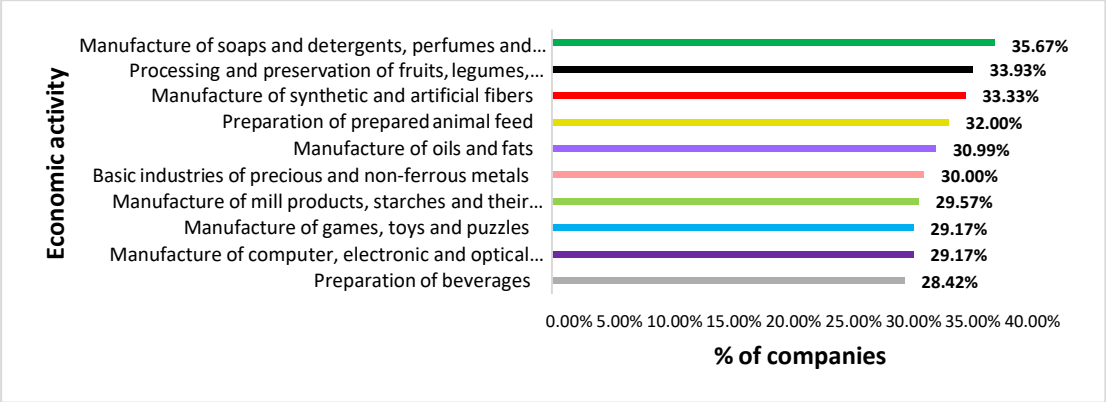


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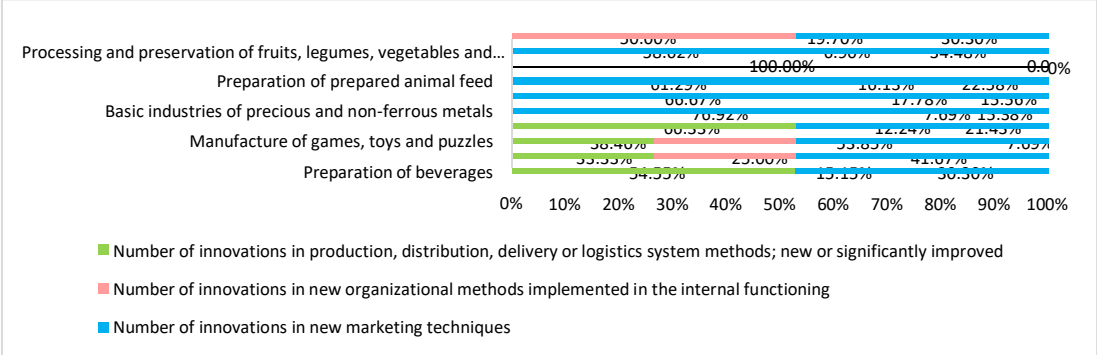
Figure 13 shows that 50% of *Manufacture of soaps and detergents, perfumes and toilet preparations* method or technique innovations were in production, distribution, delivery or logistics system methods; new or significantly improved, while 19,70% of the innovations were in new organizational methods implemented in the internal functioning and 30,30% were in new marketing techniques. Finally, 58,62% of *Processing and preservation of fruits, legumes, vegetables and tubers* innovations were in production, distribution, delivery or logistics system methods; new or significantly improved, while 6,90% of the innovations were new organizational methods implemented in the internal functioning and 34,48% were in newmarketing techniques. (See Data analysis Excel File - C.1.2. Sheet).

Figure 13. Distribution of method or technique innovations carried out by companies, by economic activity



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

-Type of innovation impact:

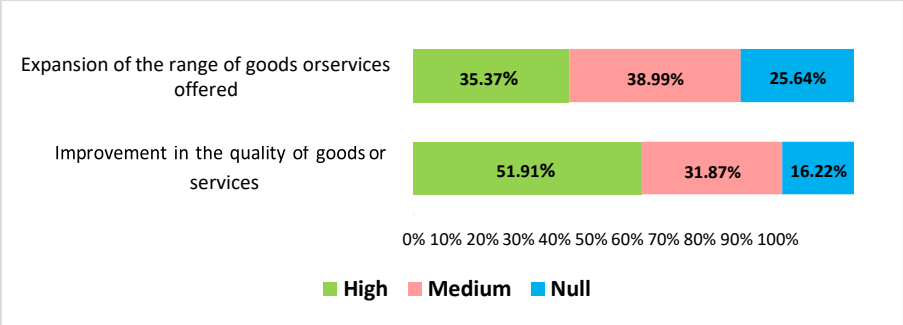
EDIT classifies the types of impact according to where they are generated:

- ✓ Product
- ✓ Market
- ✓ Process
- ✓ Other impacts

1572 innovative companies are taken (an innovative company is understood as one that during the reference period obtained new or significantly improved goods or services, either for the international or national market or for the same company; or introduced new or significantly improved methods of service delivery, or a new organizational or marketing form).

- ✓ **Product:** as seen in Figure 14, taking into account the impacts of the introduction of innovations on the product, 35,37% of innovative companies rated the *Expansion of the range of goods or services offered* as high importance, while the *Improvement in the quality of goods or services* was considered of high importance by 51.9% of innovative companies, the latter being considered of greater impact. (See Data analysis Excel File - C.1.3. Sheet)

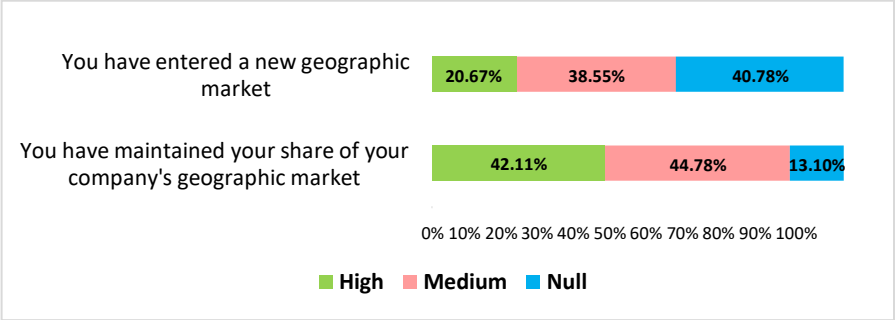
Figure 14. Distribution of industrial companies according to the degree of importance assigned to the impact on the product.



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

- ✓ **Market:** regarding market-related aspects, Figure 15 shows that 20.67% of innovative companies rated the fact of *having entered a new geographic market* as "high", while the aspect of *having maintained the share of the company's geographic market* was considered highly important for 42.11% of the innovative companies, the latter being considered of greater impact. (See Data analysis Excel File - C.1.3. Sheet).

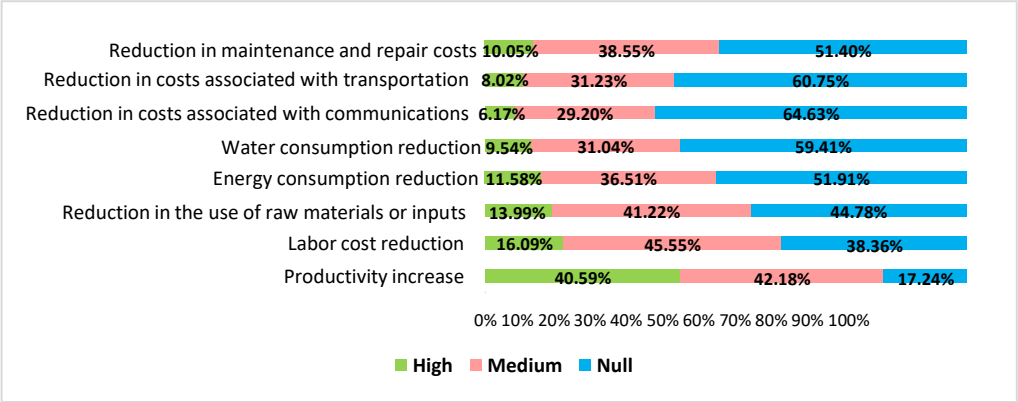
Figure 15. Distribution of industrial companies according to the degree of importance assigned to the impact on the market



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

✓ **Process:** regarding the impacts related to the production process, Figure 16 depicts that the companies assigned the highest percentage of "high" importance to *Productivity increase*, with 40.6% and the least valued aspect was R*eduction in costs associated with communications* with 6,17%. (See Data analysis Excel File - C.1.3. Sheet)

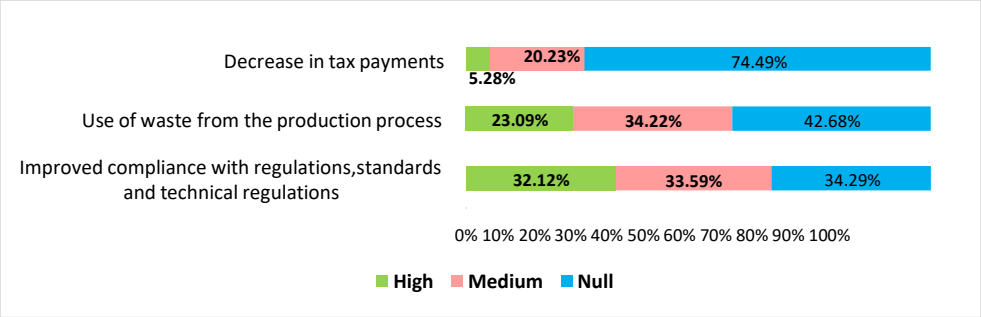
Figure 16. Distribution of industrial companies according to the degree of importance assigned to the impact on the process.



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

✓ **Other impacts:** considering other impacts in Figure 17, the aspect considered the most important was the *Improved compliance with regulations, standards and technical regulations* with 32,12% of the innovative companies while 5,28% of these companies rated the *Decrease in tax payments* as the least important one. (See Data analysis Excel File - C.1.3. Sheet)

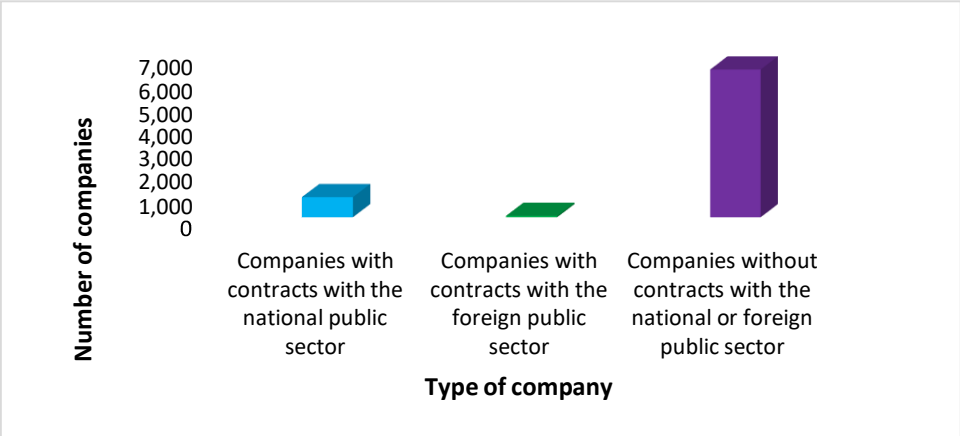
Figure 17. Distribution of industrial companies according to the degree of importance assigned to other impacts.



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

-Type of contracts: Figure 18 shows that most companies (87,29%), did not have contracts with the national or foreign public sector. On the other hand, 11,89% had contracts with the national public sector and 0,82% of the companies had contracts with the foreign public sector. (See Data analysis Excel File - C.1.4. Sheet)

Figure 18. Distribution of industrial companies according to their contracts.

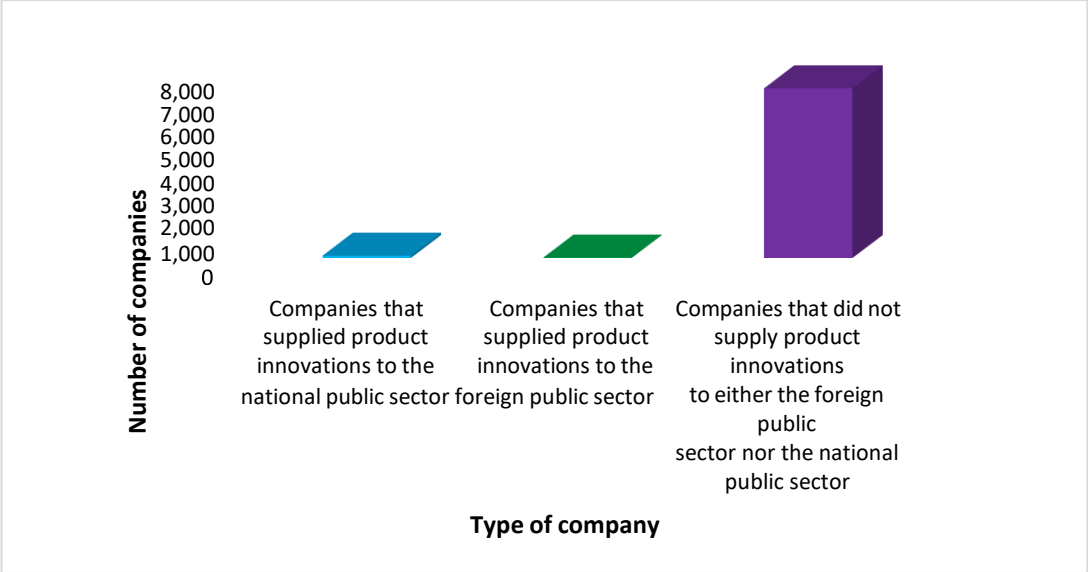


Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

-Type of sector

According to Figure 19, most companies (98,41%) did not supply product innovations to either the foreign public sector nor the national public sector. On the other hand, 1,35% of the companies supplied product innovations to the national public sector and 0,24% of them supplied product innovations to the foreign public sector. (See Data analysis Excel File - C.1.4. Sheet).

Figure 19. Distribution of industrial companies according to the sector where they supplied products.



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

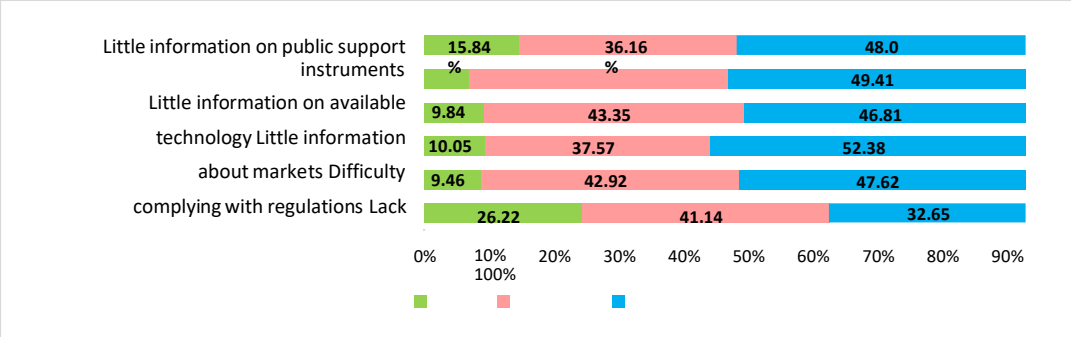
-Types of obstacle to innovation (for innovative and potentially innovative companies)The types of obstacles are subclassified as follows:

- ✓ Obstacles associated with internal information and capacities
- ✓ Obstacles associated with risks
- ✓ Obstacles associated with the environment

1850 innovative and potentially innovative companies are taken (an *innovative company* is understood as one that during the reference period obtained new or significantly improved goods or services, either for the international or national market or for the same company; or introduced new or significantly improved methods of service delivery, or a new organizational or marketing form and *a potentially innovative company* is that one that at the time of completing the survey had not obtained any innovation in the reference period, but reported having an innovation project in process or having abandoned, either to obtain a new product or significantly improved in the international market, in the national market, or for the company; or for the introduction of new or significantly improved methods of service delivery, or of a new organizational or marketing technique).

- ✓ **Obstacles associated with internal information and capacities:** Figure 20 depicts that most innovative and potentially innovative companies (26,22%) rated the *Scarcity of own resoures* as high importance, while the *Little information on available technology* was considered of high importance by 7,57% of innovative companies, the first one being considered as the biggest obstacle. (See Data analysis Excel File - C.1.5. Sheet)

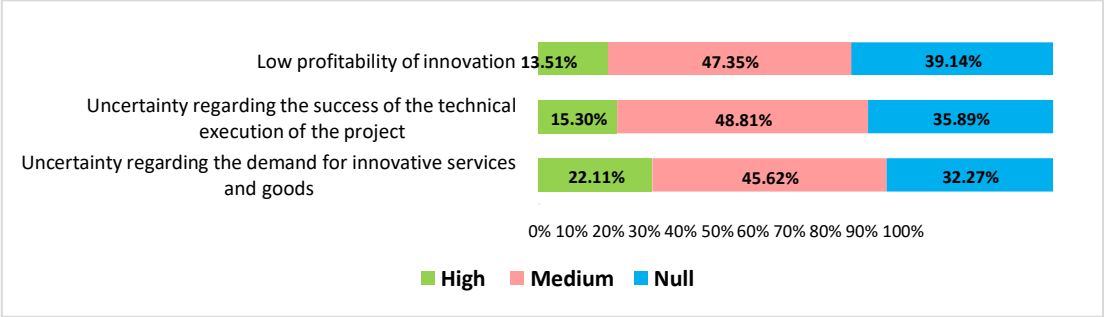
Figure 20. Distribution of innovative and potentially innovative companies according to obstacles associated with internal information and capacities.



Source: DANE, Technological Development, and Innovation Survey – EDIT - Own creation

✓ **Obstacles associated with risks:** Figure 21 indicates that the innovative and potentially innovative companies assigned the highest percentage of "high" importance to *Uncertainty regarding the demand for innovative services and goods*, with 22,11% and the least valued aspect was *Low profitability of innovation* with 6,17%. (See Data analysis Excel File - C.1.5. Sheet).

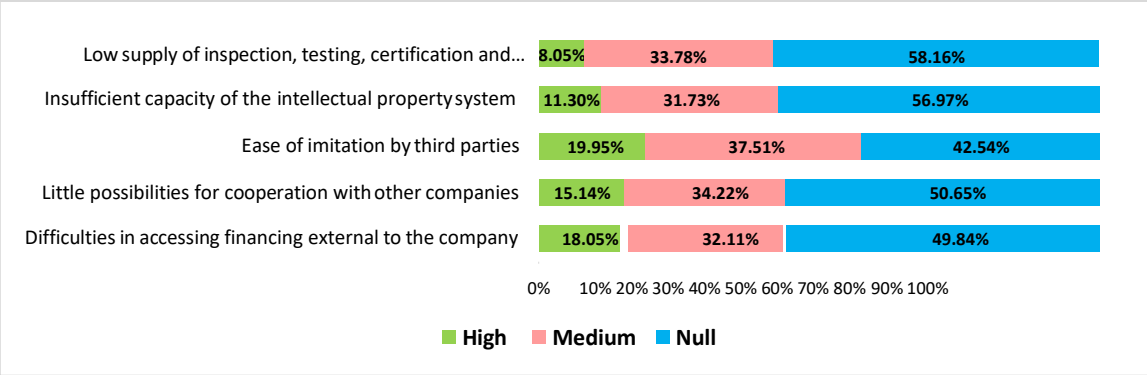
Figure 21. Distribution of innovative and potentially innovative companies according to obstacles associated with risks.



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

✓ **Obstacles associated with the environment:** the aspect that was given the most importance was the *Ease of imitation by third parties* with 19,95% of the innovative and potentially innovative companies while 8,05% of these companies rated the *Low supply of inspection, testing, certification and verification services* as the least important one. It can be observed in Figure 22. (See Data analysis Excel File -C.1.5. Sheet)

Figure 22. Distribution of innovative and potentially innovative companies according to obstacles associated with the environment.



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

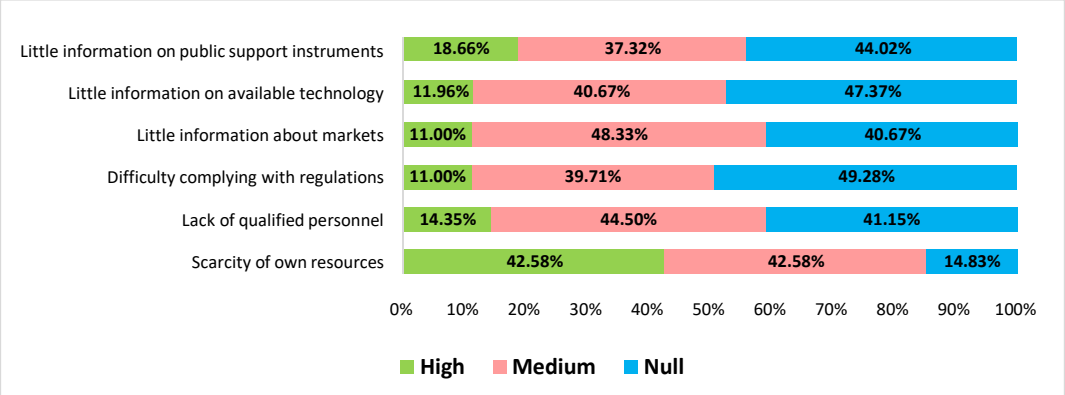
-Types of obstacle to innovation (for companies that intended to innovate): The types of obstacles are sub-classified as in the case of innovative and potentially innovative companies:

- ✓ Obstacles associated with internal information and capacities.
- ✓ Obstacles associated with risks.
- ✓ Obstacles associated with the environment.

209 companies that intended to innovate (*a company that intended to innovate* is that one that during the reference period had the intention of carrying out a project for the introduction of new or significantly improved goods or services, and / or the implementation of new or significantly improved processes, new organizational methods, or techniques of new marketing)

- ✓ **Obstacles associated with internal information and capacities:** Figure 23 depicts that most companies which intended to innovate (42,58%) rated the *Scarcity of own resoures* as high importance, while the *Little information about markets* and the *Difficulty complying with regulations* were considered of high importance by 11,00% of innovative companies, the first one being considered as the biggest obstacle. (See Data analysis Excel File - C.1.6. Sheet)

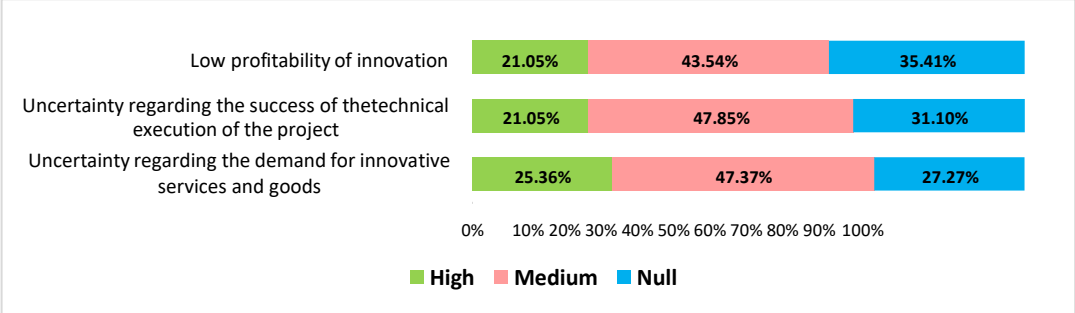
Figure 23. Distribution of companies that intended to innovate according to obstacles associated with internal information and capacities.



Source: DANE, Technological Development, and Innovation Survey – EDIT - Own creation

✓ **Obstacles associated with risks:** Figure 24 allows us to observe that the companies which intended to innovate assigned the highest percentage of "high" importance to *Uncertainty regarding the demand for innovative services and goods*, with 25,36% and the least valued aspect were *Low profitability of innovation* and *Uncertainty regarding the success of the technical execution of the project* with 21,05%. (See Data analysis Excel File - C.1.6. Sheet)

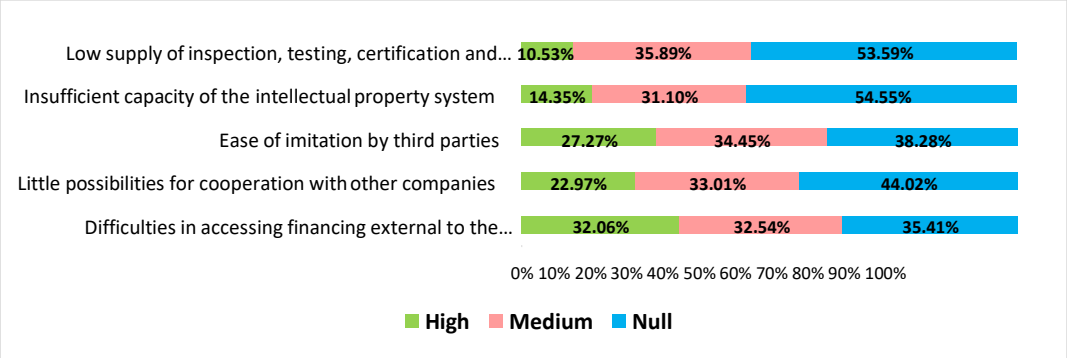
Figure 24. Distribution of companies that intended to innovate according to obstacles associated with risks.



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

✓ **Obstacles associated with the environment:** Figure 25 evidences that the aspect that was given the most importance was the *Difficulties in accessing financing external to the company* with 32,06% of the companies which intended to innovate while 10,53% of these companies rated the *Low supply of inspection, testing, certification and verification services* as the least important one. (See Data analysis Excel File - C.1.6. Sheet).

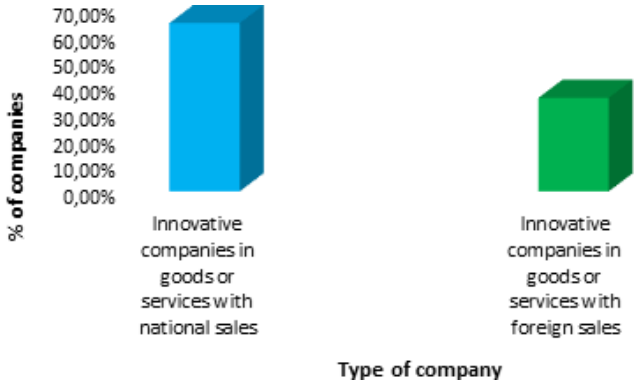
Figure 25. Distribution of companies that intended to innovate according to obstacles associated with the environment.



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

- Sales corresponding to innovations: Figure 26 indicates that 64,27% of the companies are innovative in goods or services with national sales and 35,73% of the companies are innovative in goods or services with foreign sales. (See Data analysis Excel File - C.1.7. Sheet)

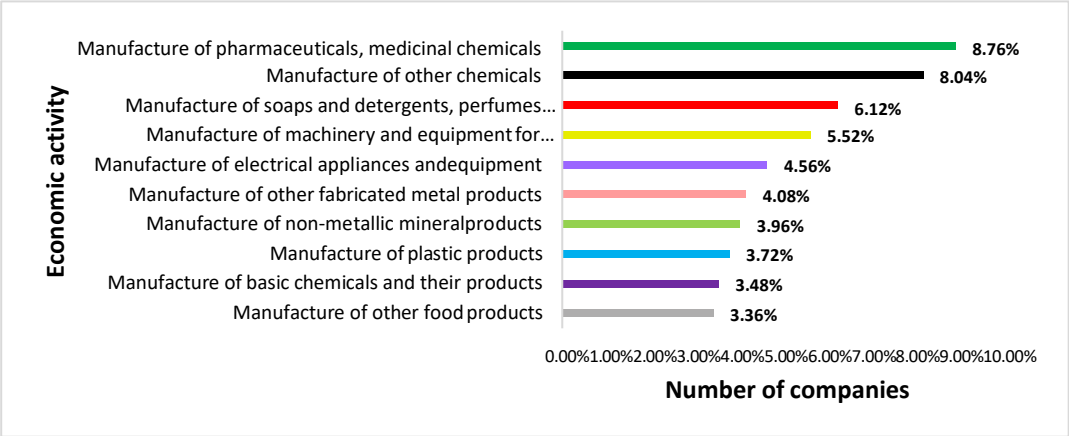
Figure 26. Distribution of companies according to percentage of sales corresponding to innovations, by geographical area of sales.



Source: DANE, Technological Development and Innovation Survey – EDIT- Own creation.

According to Figure 27, the innovative companies belonging to *Manufacture of pharmaceuticals, medicinal chemicals* represent the highest percentage of national sales (8,76%), followed by *Manufacture of other chemicals* (8,04%) and finally, *Manufacture of soaps and detergents, perfumes and toilet preparations* with 6,12%. This graph was made taking into account the 10 economic activities with the highest number of national sales. (See Data analysis Excel File - C.1.7. Sheet)

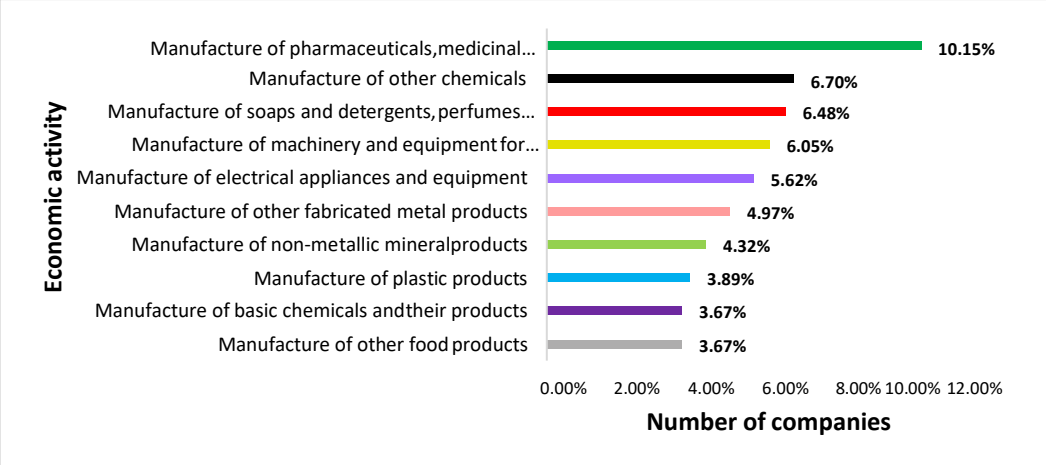
Figure 27. Distribution of companies by economic activity according to percentage of national sales.



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

According to Figure 28, the innovative companies belonging to *Manufacture of pharmaceuticals, medicinal chemicals* represent the highest percentage of foreign sales (10,15%), followed by *Manufacture of other chemicals* (6,70%) and finally, *Manufacture of soaps and detergents, perfumes and toilet preparations* with 6,48%. This graph was made taking into account the 10 economic activities with the highest number of foreign sales. (See Data analysis Excel File - C.1.7. Sheet)

Figure 28. Distribution of companies by economic activity according to percentage of foreign sales.



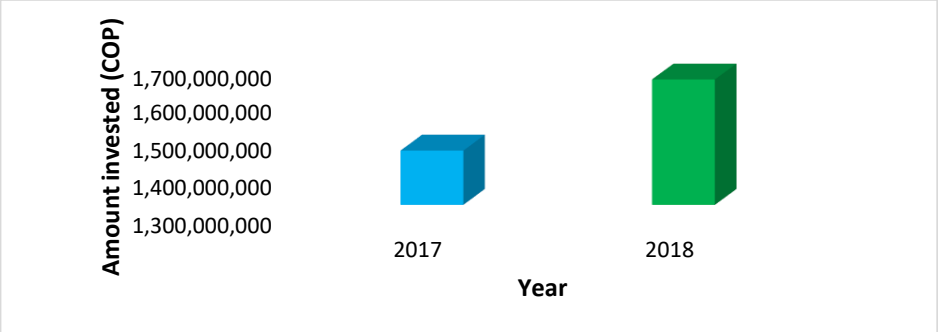
Source: DANE, Technological Development and Innovation Survey – EDIT- Own creation

For both cases (national and foreign sales) the same 10 economic activities represent the highest portion of sales for each case.

-Investment in Scientific, Technological and Innovation Activities: From Figure 29, we can conclude that the overall amount of money invested in Scientific, Technological and Innovation activities (Internal R&D activities, Acquisition of external R&D, Acquisition of machinery and equipment, Information and Communication Technologies, Marketing,

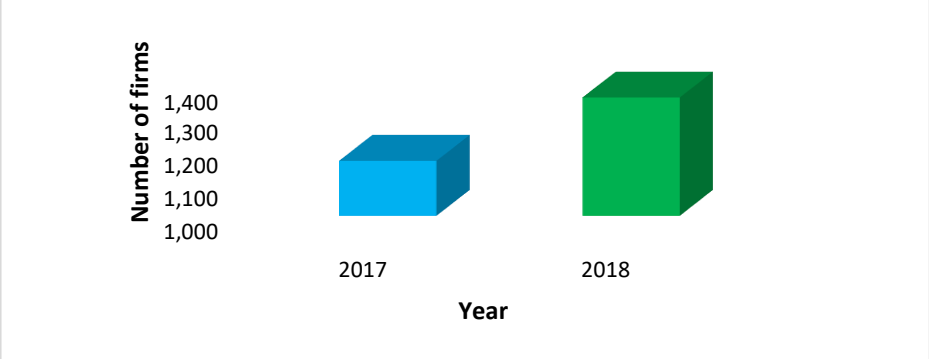
Technology transfer and / or acquisition of other knowledge, Technical assistance and consulting, Engineering and industrial design, Training and qualification) increased from year 2017 to year 2018. Figure 30 supports this information showing that the number of companies that have invested in this type of activity increased from 2017 to 2018. (See Data analysis Excel File - C.2.1. Sheet)

Figure 29. Overall amount invested in Scientific, Technological and Innovation activities in 2017 and 2018



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

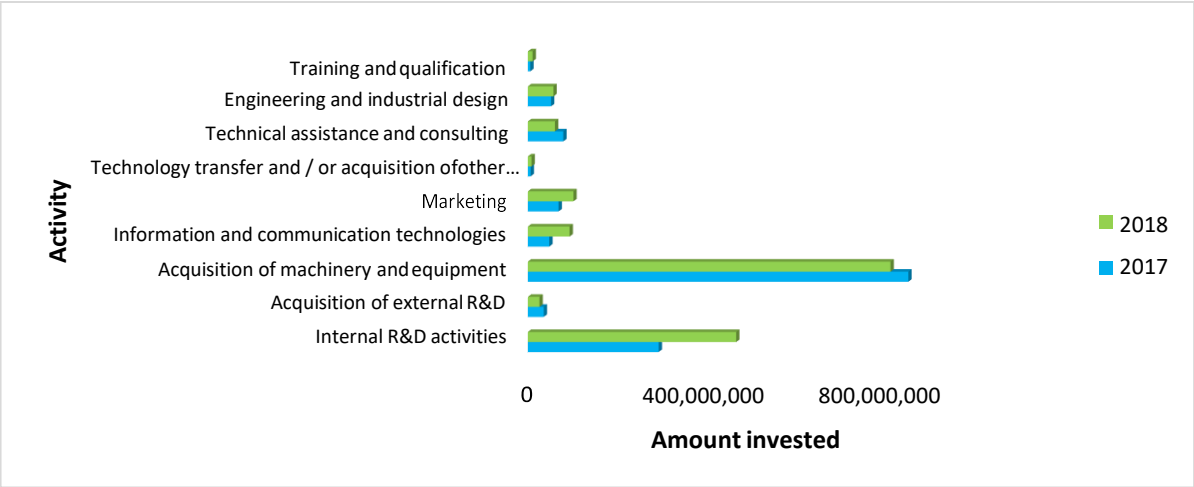
Figure 30. Number of firms that invested in Scientific, Technological and Innovation activities in 2017 and 2018



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

Figure 31 depicts the amount invested on each activity for 2017 and 2018 and it is possible to see that *Acquisition of machinery and equipment* was the activity that was invested the most during both years (the amount of money was greater in the year 2017), followed by *Internal R&D activities* (the amount of money was greater in the year 2018). (See Data analysis Excel File - C.2.1. Sheet)

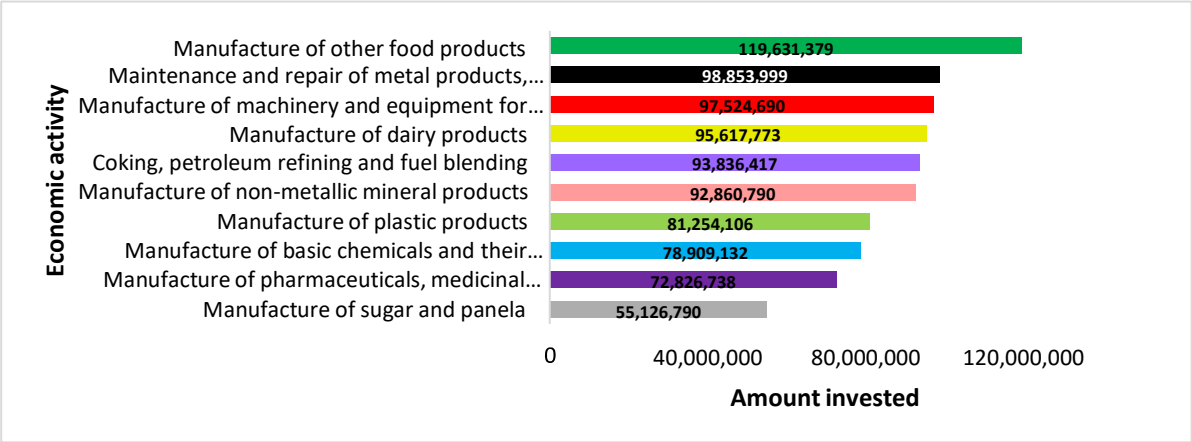
Figure 31. Amount of money invested on each Scientific, Technological and Innovation activity.



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

Figure 32 represents the 10 industrial activities that made the highest investments on Scientific, Technological and Innovation activities in 2017: the first place is for *Manufacture of other food products*, followed by *Manufacture and repair of metal products, machinery and equipment* and finally *by Manufacture of machinery and equipment for general use.* (See Data analysis Excel File - C.2.1. Sheet)

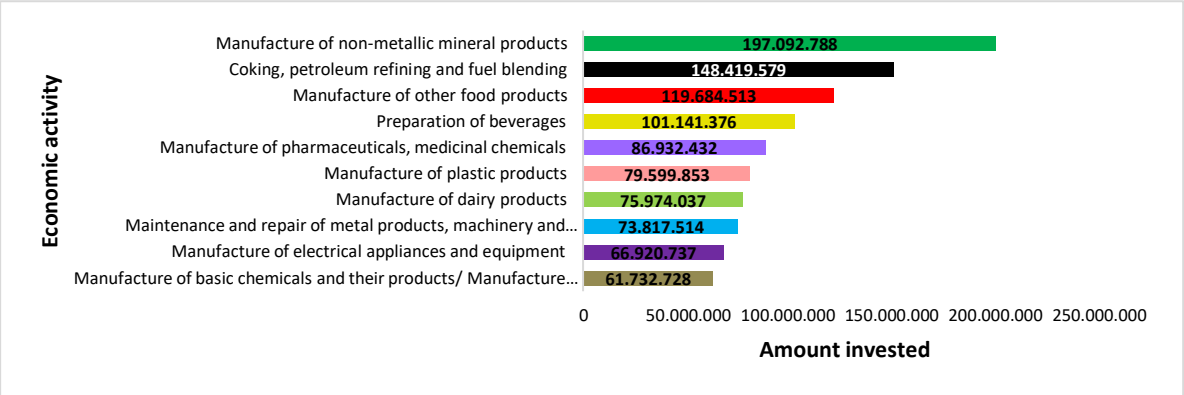
Figure 32. Amount of money invested on Scientific, Technological and Innovation activities in 2017 by economic activity.



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

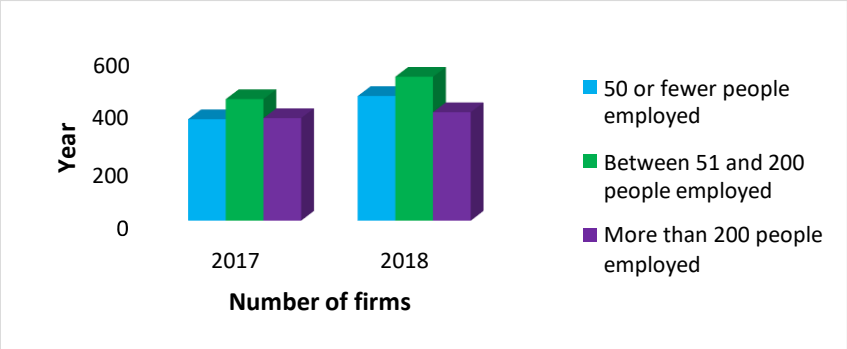
Figure 33 represents the 10 industrial activities that made the highest investments on Scientific, Technological and Innovation activities in 2018: the first place is for *Manufacture of non-metallic mineral products*, followed by *Coking, petroleum refining and fuel blending* and finally *by Manufacture of other food products.* (See Data analysis Excel File - C.2.1. Sheet)

Figure 33. Amount of money invested in Scientific, Technological and Innovation activities in 2018 by economic activity.



Source: DANE, Technological Development and Innovation Survey – EDIT- Own creation

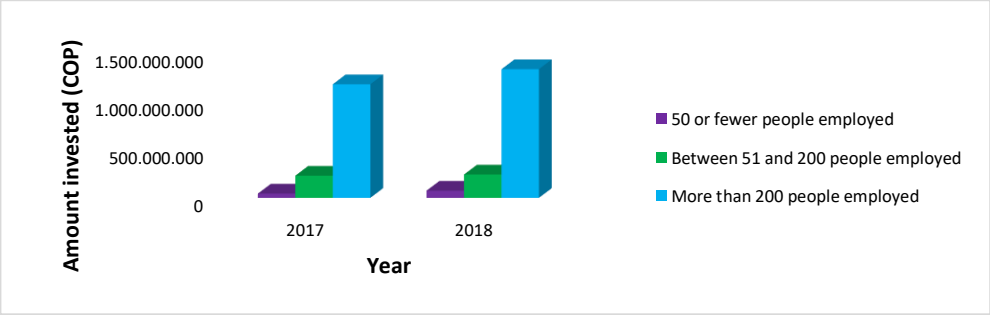
-Companies that invested in Scientific, Technological and Innovation Activities (ACTI), by scale of employed personnel according to economic activity: Figure 34 evidences that the industrial companies with more than 50 employees but less than 200, represent the highest portion of the total of companies that invested in Scientific, Technological and Innovation activities: 37,36% in 2017 and 38,20% in 2018. (See Data analysis Excel File - C.2.2. Sheet).*Figure 34.* Number of companies that invested in Scientific, Technological and Innovation activities by scale of employed personnel.



Source: DANE, Technological Development and Innovation Survey – EDIT- Own creation

However, Figure 35 indicates that the industrial companies with more than 200 employees invested the highest amounts of money in Scientific, Technological and Innovation activities for the years 2017 and 2018. (See Data analysis Excel File - C.2.2. Sheet).

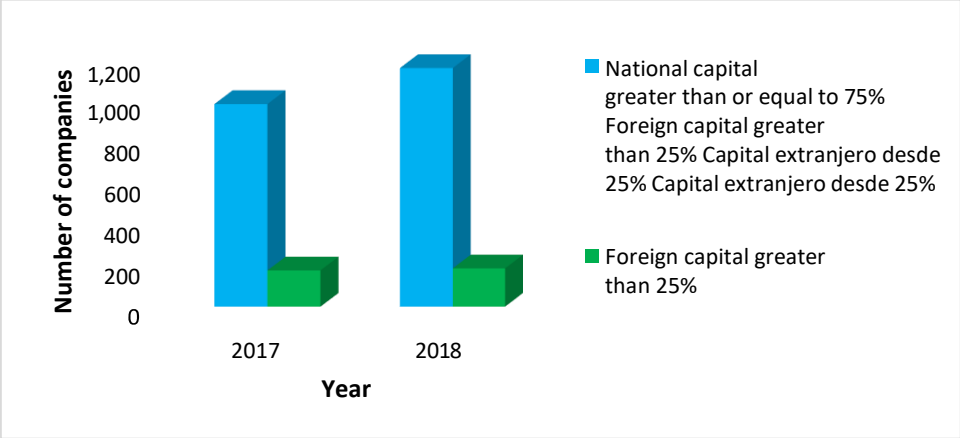
Figure 35. Amount of money invested in Scientific, Technological and Innovationactivities by scale of employed personnel in industrial companies.



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

-Companies that invested in Scientific, Technological and Innovation Activities by type of company ownership: According to Figure 36, we can conclude that the industrial companies with national capital greater than or equal to 75% represent the highest portion of the total of companies that invested in Scientific, Technological and Innovation activities: 84,81% in 2017 and 86,15% in 2018. (See Data analysis Excel File - C.2.3. Sheet).

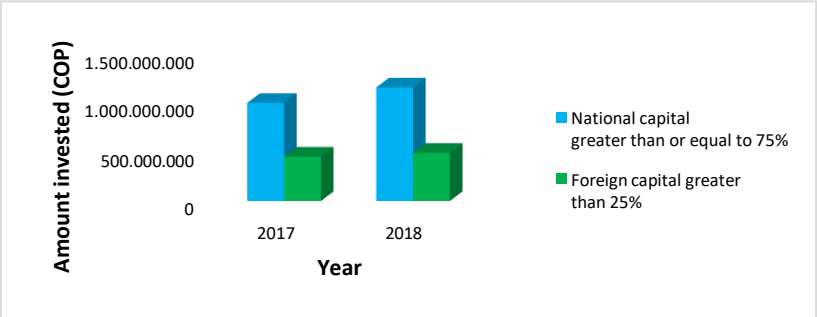
Figure 36. Number of companies that invested in Scientific, Technological and Innovation activities by ownership type.



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

Looking at Figure 37, it is possible to state that the industrial companies with national capital greater than or equal to 75% invested the highest amounts of money in Scientific, Technological and Innovation activities compared to companies with foreign capital greater than 25%, for the years 2017 and 2018. (See Data analysis Excel File - C.2.3. Sheet.)

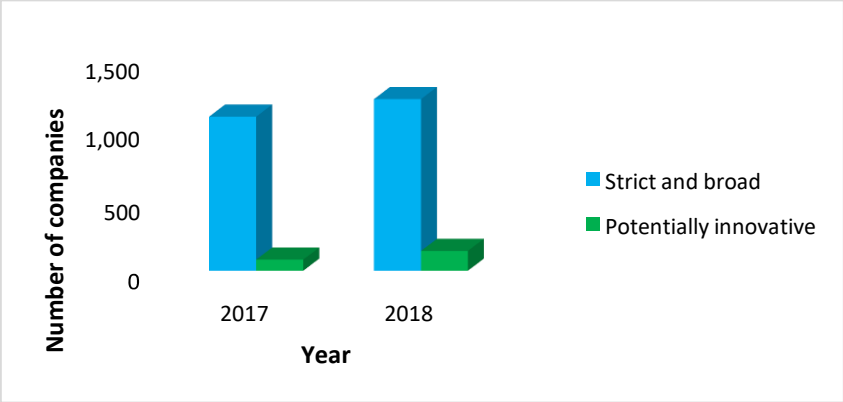
Figure 37. Amount of money invested in Scientific, Technological and Innovation activities by company ownership type.



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

- Companies that invested in Scientific, Technological and Innovation Activities, by type of company (degree of innovation): According to Figure 38, the strict and broad companies represent the highest portion of the total of companies that invested in Scientific, Technological and Innovation activities compared to potentially innovative companies for both 2017 and 2018. (See Data analysis Excel File - C.2.4. Sheet)

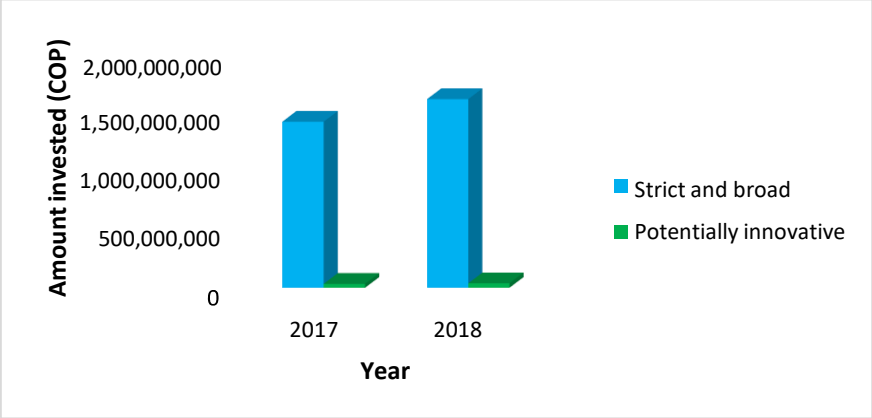
Figure 38. Number of companies that invested in Scientific, Technological and Innovation activities by degree of innovation.



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

Figure 39 depicts that the strict and broad companies invested the highest amounts of money in Scientific, Technological and Innovation activities compared to potentially innovative companies for the years 2017 and 2018. (See Data analysis Excel File - C.2.4. Sheet).

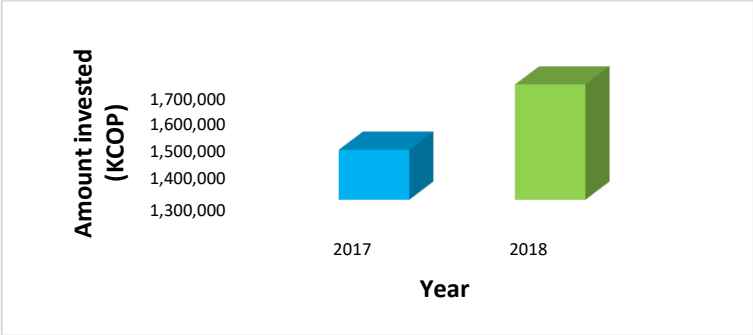
Figure 39. Amount of money invested in Scientific, Technological and Innovationactivities by degree of innovation.



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

-Amount invested by the companies that invested in Scientific, Technological and Innovation Activities, by source of financing: Figure 40 shows that the amount of resources invested in these activities was higher in the year 2018 with a variation of 13,64%. (See Data analysis Excel File - C.3.1. Sheet)

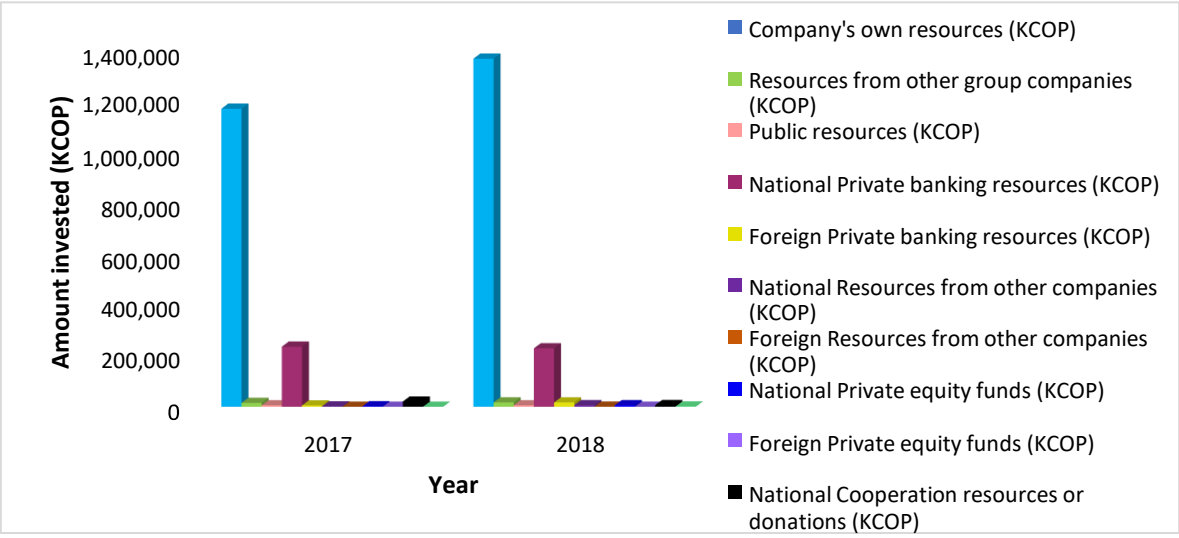
Figure 40. Amount of money invested in Scientific, Technological and Innovationactivities by year.



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

By looking at Figure 41, we can conclude that the funding source with which the industrial companies invested the most was their own resources, followed by National Private banking resources for both 2017 and 2018 years. The result that says that the main source of financing for innovation is own resources coincides with most of the research carried out in both developed and developing countries. (See Data analysis Excel File - C.3.1. Sheet)

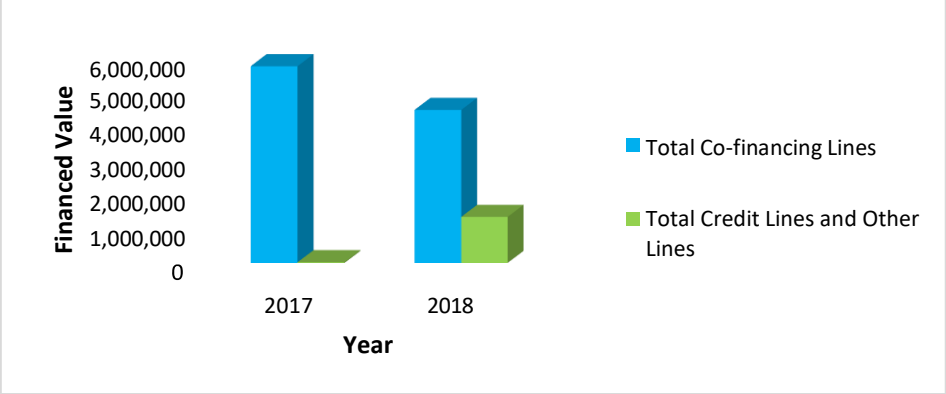
Figure 41. Amount of money invested in Scientific, Technological and Innovationactivities with respect to each funding source by year.



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

-Financing with public resources of Scientific, Technological and Innovation Activities by public sector financing lines: In this section, we can identify that the *Public Resources* are divided in *Co-financing Lines* and *Credit Lines and Other Lines*. Figure 42 evidences that the public resources from which the industrial companies invested the most was *Co-financing Lines* for both 2017 and 2018. (See Data analysis Excel File - C.3.2. Sheet)

Figure 42. Amount of money invested in Scientific, Technological and Innovation activities from each type of public resources.



Source: DANE, Technological Development and Innovation Survey – EDIT- Own creation

In the case of the *Credit Lines and Other Lines,* they are divided in:

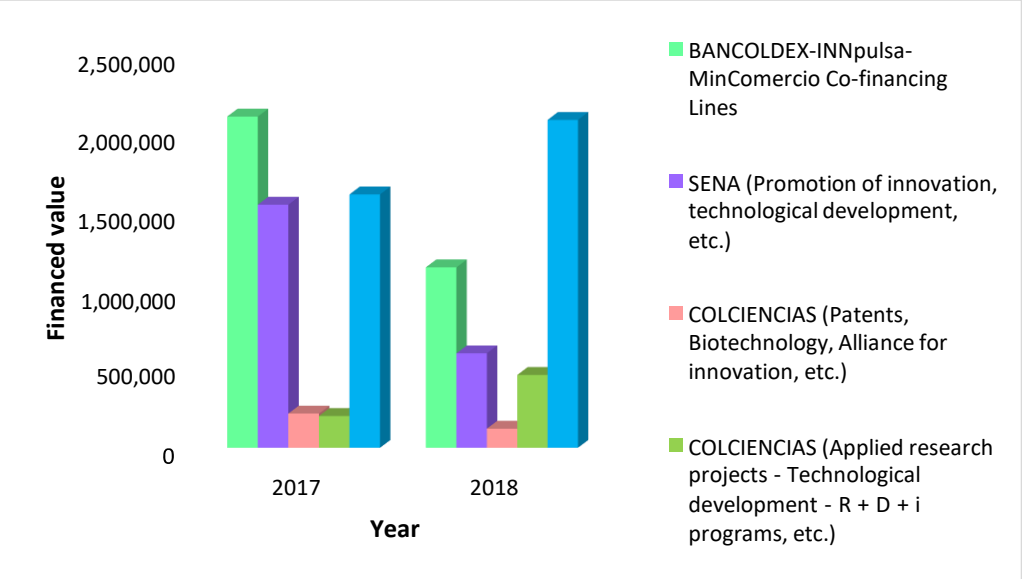
- ✓ BANCOLEX-INNpulsa-MinComerio Co-financing Lines
- ✓ SENA (Promotion of innovation, technological development, etc.)
- ✓ COLCIENCIAS (Patents, Biotechnology, Alliance for innovation, etc.)
- ✓ COLCIENCIAS (Applied research projects-Technological development-R+D

programs, etc.)

- ✓ COLCIENCIAS (Locomotive of innovation for companies)

And according to Figure 43, we can state that from these lines, the highest financed value was obtained using BANCOLDEX-INNpulsa-MinComercio in 2017 but in 2018 thehighest amount of money was financed by COLCIENCIAS (Locomotive of innovation for companies). (See Data analysis Excel File - C.3.2. Sheet).

Figure 43. Amount of money invested in Scientific, Technological and Innovationactivities from each Co-financing Line.



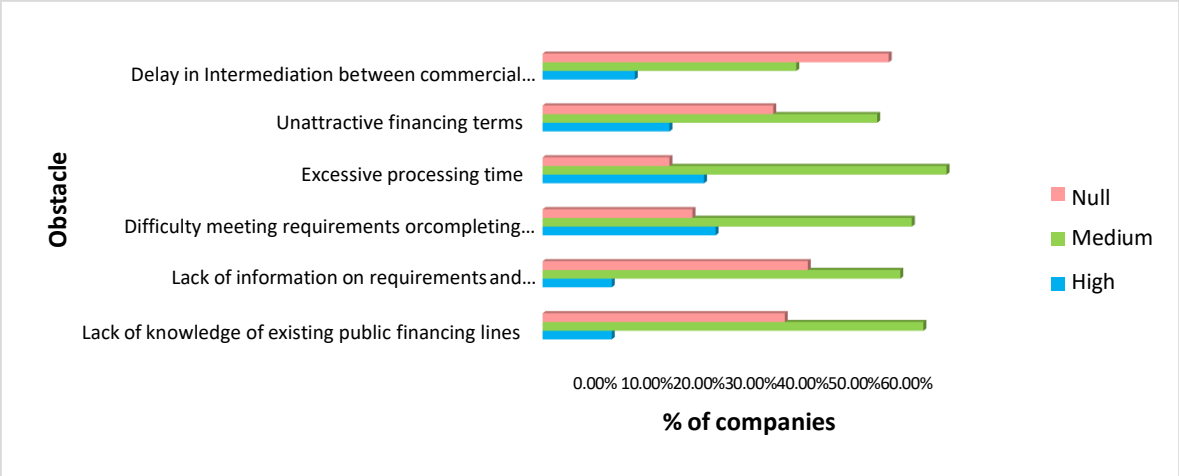
Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

-Importance of obstacles to access to public resources by companies that financed Scientific, Technological and Innovation Activities with these resources: Looking at Figure 44, it is possible to conclude the level of importance given by the industrial companies to the different types of obstacle:

- ✓ *Delay in intermediation between commercial banks and public lines of credit* was considered of null importance by the greatest portion of the industrial companies (50%)
- ✓ *Unattractive financing terms* was rated with medium importance by most industrial companies (48,33%).
- ✓ *Excessive processing time* was given medium importance by the highest percentage of industrial companies that used public resources (58,33%).
- ✓ *Difficulty meeting requirements or completing paperwork* was considered with medium importance by the highest number of industrial companies that used public resources (53,33%)
- ✓ *Lack of information on requirements and procedures* was rated with medium importance by most industrial companies (51,67%)
- ✓ *Lack of knowledge of existing public financing lines* was given medium importance by the greatest portion of the industrial companies that used public resources (55%).

In this vein, almost all obstacles were rated with medium importance except *Delay in intermediation between commercial banks and public lines of credit*, whose importance was determined as null. On the other hand, the percentage of companies that rated *Difficulty meeting requirements or completing paperwork* as highly important (25%) represents the greatest portion of companies that rated an obstacle with high importance. (See Data analysis Excel File - C.3.3. Sheet)

Figure 44. Importance of obstacles to access to public resources bycompanies that financed Scientific, Technological and Innovation Activities with these resources, by type of obstacles.



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

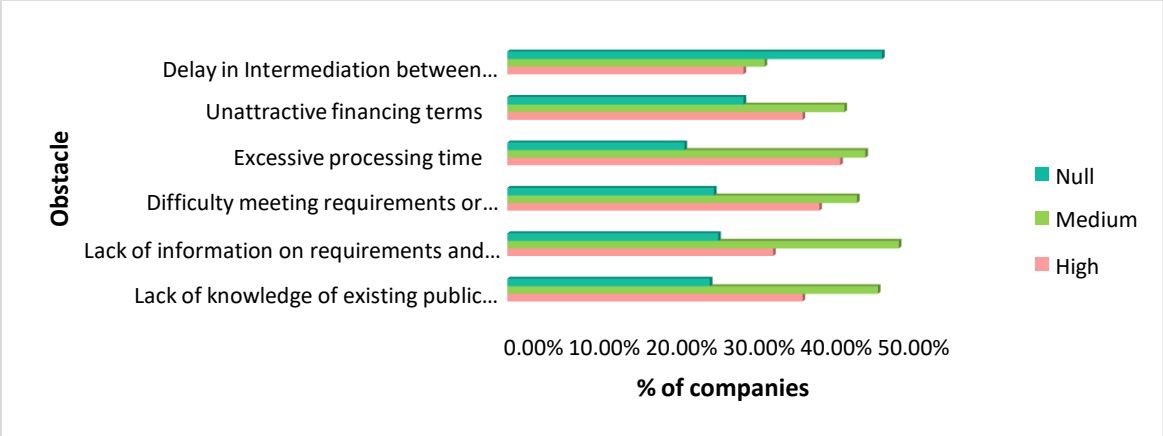
-Importance of obstacles to access to public resources by companies that intended to access such resources to finance Scientific, Technological and Innovation Activities: Figure 45 depicts the level of importance given by the industrial companies to the different types of obstacle:

- ✓ *Delay in intermediation between commercial banks and public lines of credit* was rated with null importance by most industrial companies (43,20%).
- ✓ *Unattractive financing terms* was considered of medium importance by the greatest portion of the industrial companies (38,83%)
- ✓ *Excessive processing time* was given medium importance by the greatest portion of the industrial companies that intended to access public resources (41,26%).
- ✓ *Difficulty meeting requirements or completing paperwork* was rated with medium importance by most industrial companies (40,29%)
- ✓ *Lack of information on requirements and procedures* was given medium importance by the greatest portion of the industrial companies that intended to access public resources (45,15%).
- ✓ *Lack of knowledge of existing public financing lines* was considered with medium importance by the highest number of industrial companies that intended to access public resources (42,72%)

As in the case of the firms that actually used the public resources, almost all obstacles

were rated with medium importance except *Delay in intermediation between commercial banks and public lines of credit*, whose importance was determined as null. However, the percentage of companies that rated *Excessive processing time* as highly important (38,35%) represents the greatest portion of companies that rated an obstacle with high importance. (See Data analysis Excel File - C.3.4. Sheet)

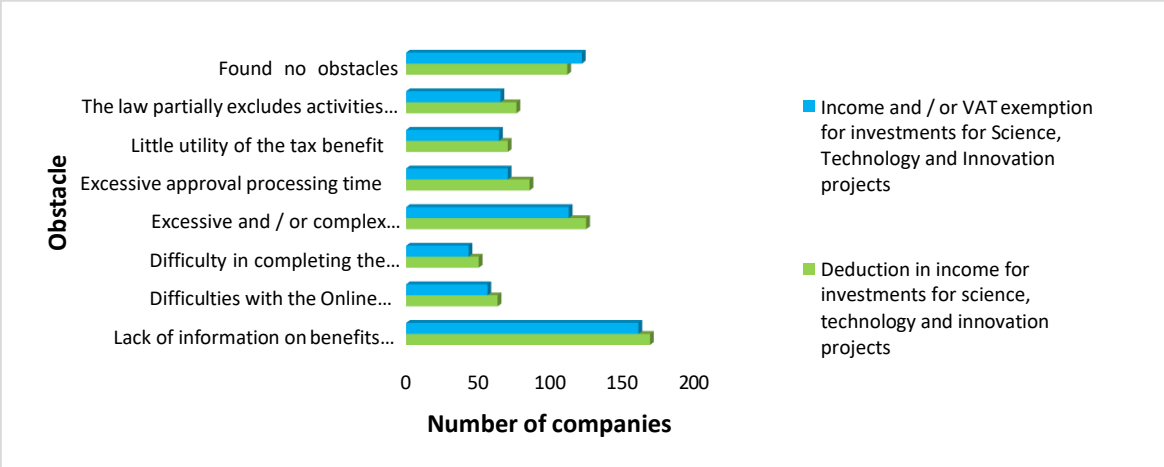
Figure 45. Importance of obstacles to access to public resources bycompanies that intended to access such resources to finance Scientific, Technological and Innovation Activities.



Source: DANE, Technological Development and Innovation Survey – EDIT- Own creation

-Obstacles for companies that invested in Science, Technology and Innovation activities when obtained or requested tax benefits: According to Figure 46, we can state that the most predominant obstacle for the industrial companies when obtained or requested tax benefits was associated with the *Lack of information on benefits and requirements* followed by the *Excessive and/or complex requirements and procedures* and by *No obstacles.* (See Data analysis Excel File - C.3.5. Sheet)

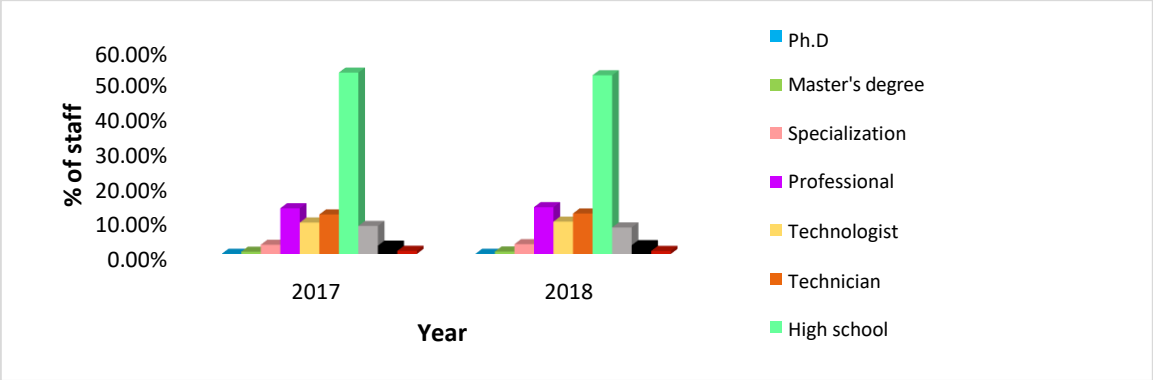
Figure 46. Obstacles for companies when obtained or requested tax benefits.



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

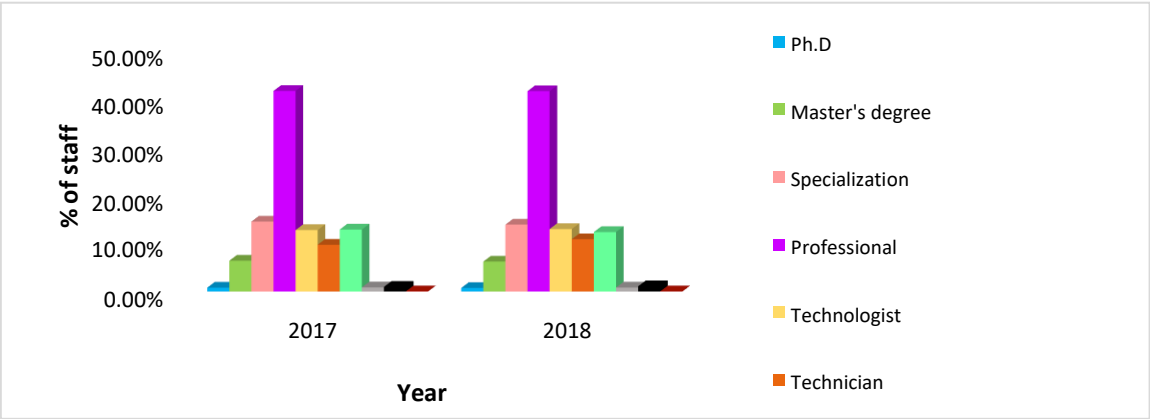
-Educational level of employed personnel: Figure 47 evidences that from the total staff belonging to the 7.529 companies, most have only a high school level of education (52,04% in 2017 and 51,28% in 2018), followed by professionals who represented 13,07% in 2017 and 13,39% in 2018 of the total staff of industrial companies. Also, it is important to recognize that the educational level less predominant in the industrial companies is Ph.D with 0,03% in 2017 and 0,04% in 2018. (See Data analysis Excel File - C.4.1. Sheet)

Figure 47. Total staff of industrial companies classified by educational level.



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation
Figure 48 shows that in the case of the staff related to Scientific, Technogical and Innovation activities, the greatest portion of them had a professional educational level (41,38% in 2017 and 41,34% in 2018), followed by specialists that represented 14,46% in 2017 and 13,84% in 2018. Also, it is important to recognize that only 0,03% of the staff in 2017 and 0,01% in 2018 did not have education, being this one the less predominant case. (See Data analysis Excel File - C.4.2. Sheet)

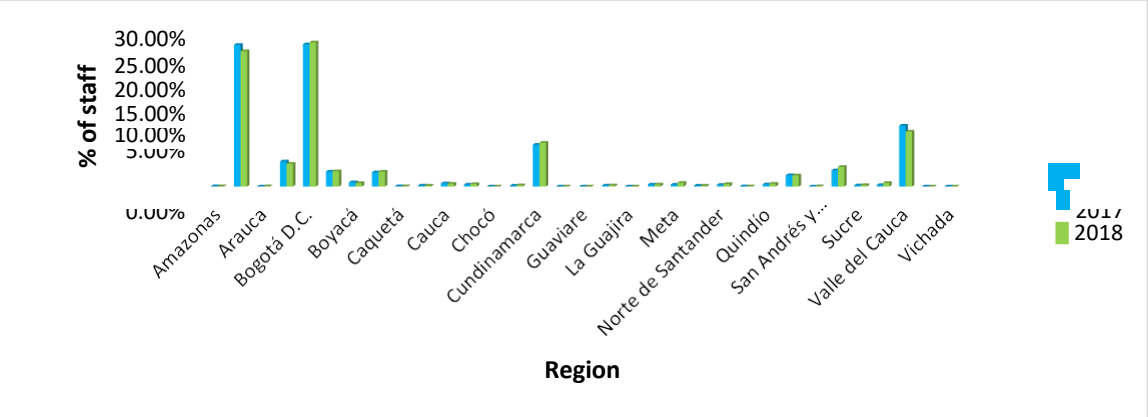
Figure 48. Total staff in Scientific, Technological and Innovation activities classified by educational level.



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

-Location of staff employed in Scientific, Technological and Innovation activities: Looking at Figure 49, we can conclude that the regions where there are the highest percentages of the total staff employed in these activities are Antioquia (28,84% and 27,58% of the staff for both 2017 and 2018 respectively) and Bogotá D.C. (28,95% and 29,37% of the staff for both 2017 and 2018 respectively). (See Data analysis Excel File - C.4.3. Sheet).

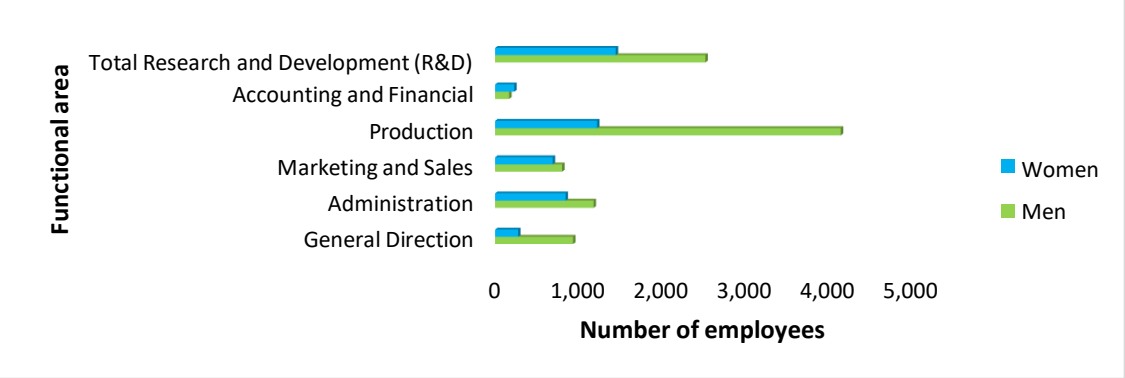
Figure 49. Distribution of the staff associated to Scientific, Technological and Innovation activities by region of Colombia.



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

-Functional area of staff with participation in scientific, technological and innovation activities: According to Figure 50, the highest number of personnel belonged to the *Production* area, representing 37,08% of the total staff and most were men, followed by *Research and Development* department with 27,45% also with most of the staff being men. (See Data analysis Excel File - C.4.4. Sheet).

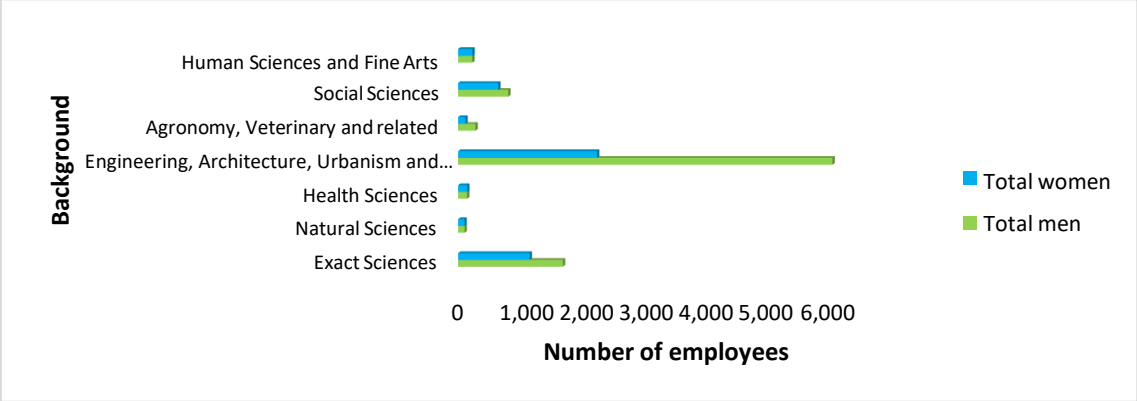
Figure 50. Classification of the staff by functional area and gender



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

-Background of the staff that participated in Scientific, Technological and Innovation activities: Figure 51 states that the highest number of the employees have a background associated with *Engineering, Architecture, Urbanism and Related,* it is 59,35% of the total of the staff of the innovative and potentially innovative companies, followed by *Exact Sciences* with 20,42%. (See Data analysis Excel File - C.4.5. Sheet).

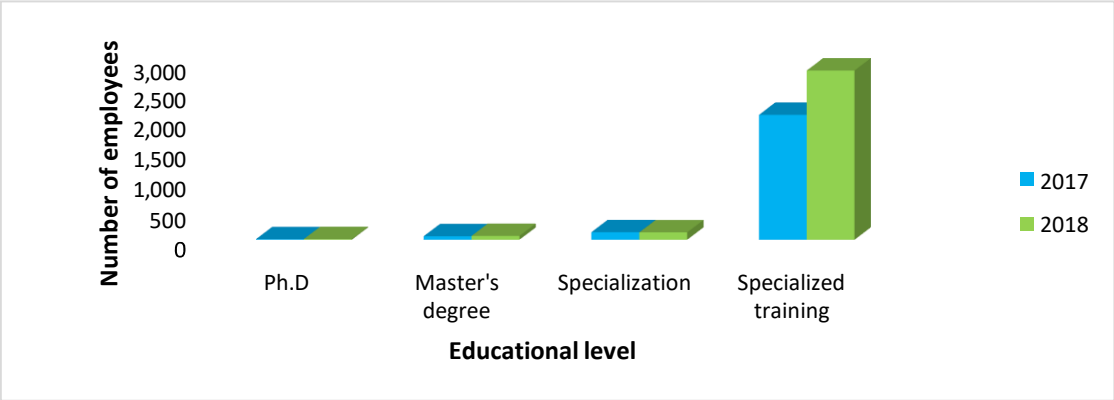
Figure 51. Classification of the staff by background and gender



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

-Type of training of personnel to carry out Scientific, Technological and Innovation activities: Looking at Figure 52, we can state that the largest number of the employees (91,54% in 2017 and 93,48% in 2018) received specialized training with the objective of carrying out Scientific, Technological and Innovation activities. (See Data analysis- C.4.6.).

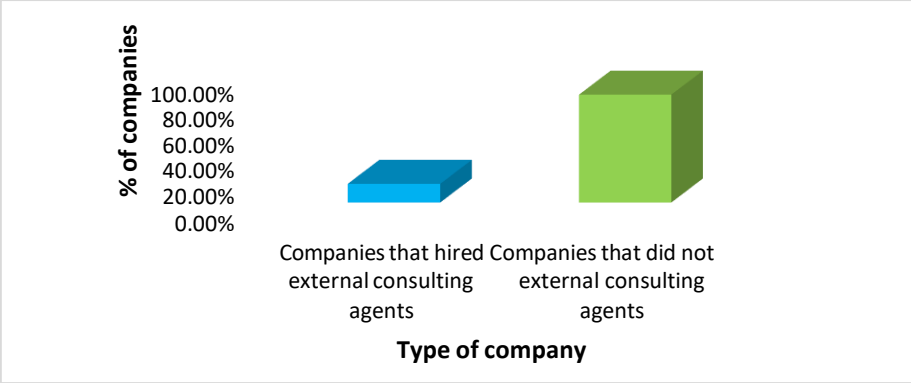
Figure 52. Distribution of personnel according to the type of training by background



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

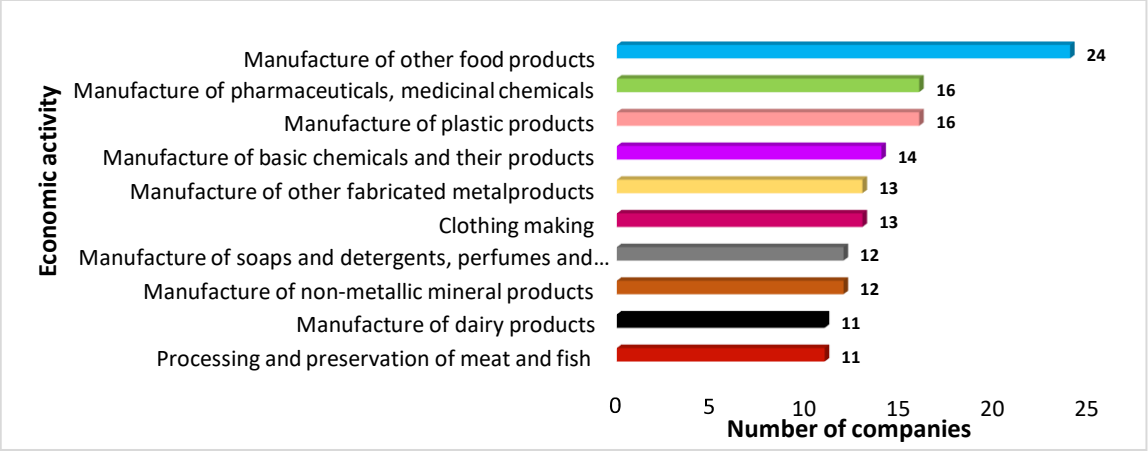
- The existence of external consultancy: Figure 53 shows that most companies hired external consulting agents (85,30% of the total of innovative and potentially innovative companies). On the other hand, Figure 54 depicts that *Manufacture of other products*, *Manufacture of pharmaceuticals, medicinal chemicals* and *Manufacture of plastic products* are the three economic activities that most hired external consultancy. (See Data analysis Excel File - C.4.7. Sheet).

Figure 53. Classification of companies according to the fact of hiring external consulting agents.



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

Figure 54. Number of companies that hired external consulting agents**,** by economic activity.

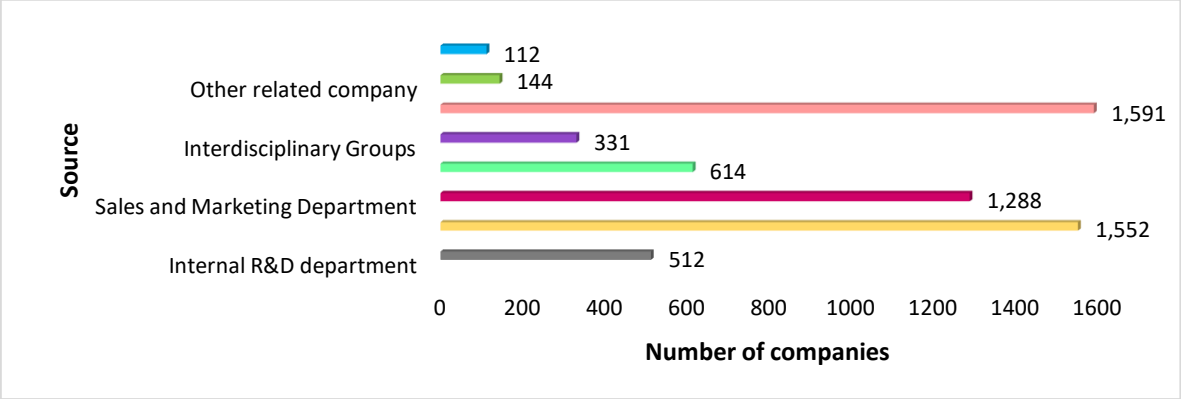


Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

-Internal sources used to obtain ideas for technological innovation: 100% of the Innovative, Potentially Innovative companies and companies that intended to innovate used Internal sources of innovation ideas generation. (See Data Analysis Excel File - C.5.1. Sheet).

Looking at Figure 55, we can state that most ideas about technological innovation came mainly from *Company Executives* and from *Production or Operations Department.*

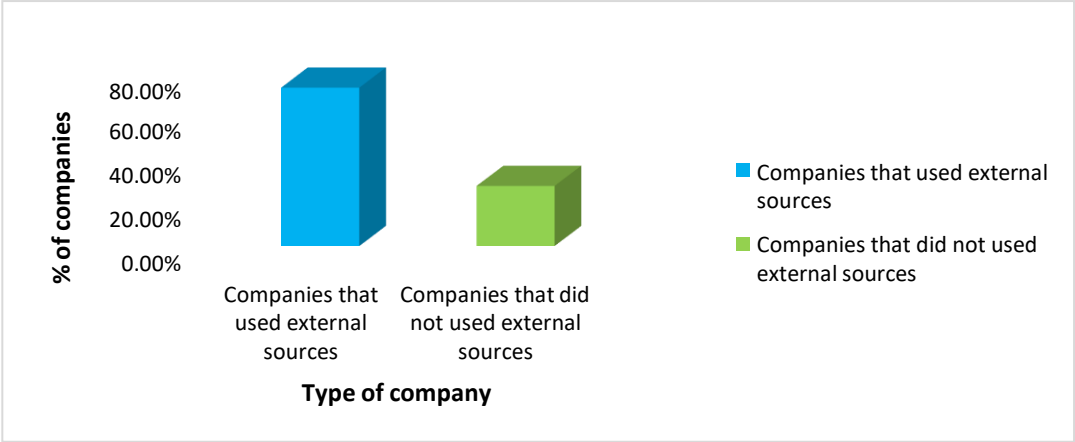
Figure 55. Internal sources of technological innovation ideas obtained by Innovative, Potentially Innovative companies and companies that intended to innovate.



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

-External sources used to obtain ideas for technological innovation: Figure 56 shows that 72,46% of the Innovative, Potentially Innovative companies and companies that intended to innovate used External sources of innovation ideas generation. (See Data analysis Excel File - C.5.2. Sheet).

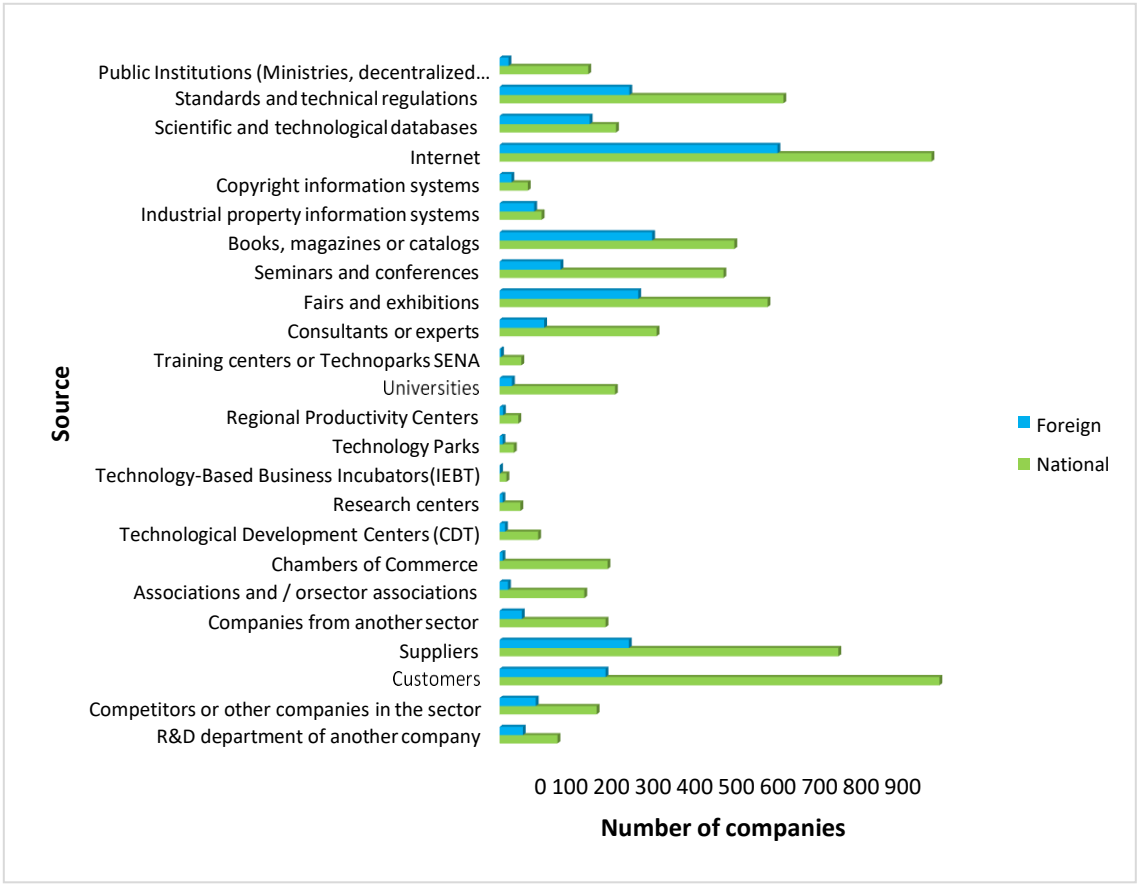
Figure 56. Companies classified according to the use of external sources to obtain technological innovation ideas.



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

Looking at Figure 57, we can state that most ideas about technological innovation came mainly from *National Customers* and from *Internet (national websites).* (See Data analysis Excel File - C.5.2. Sheet).

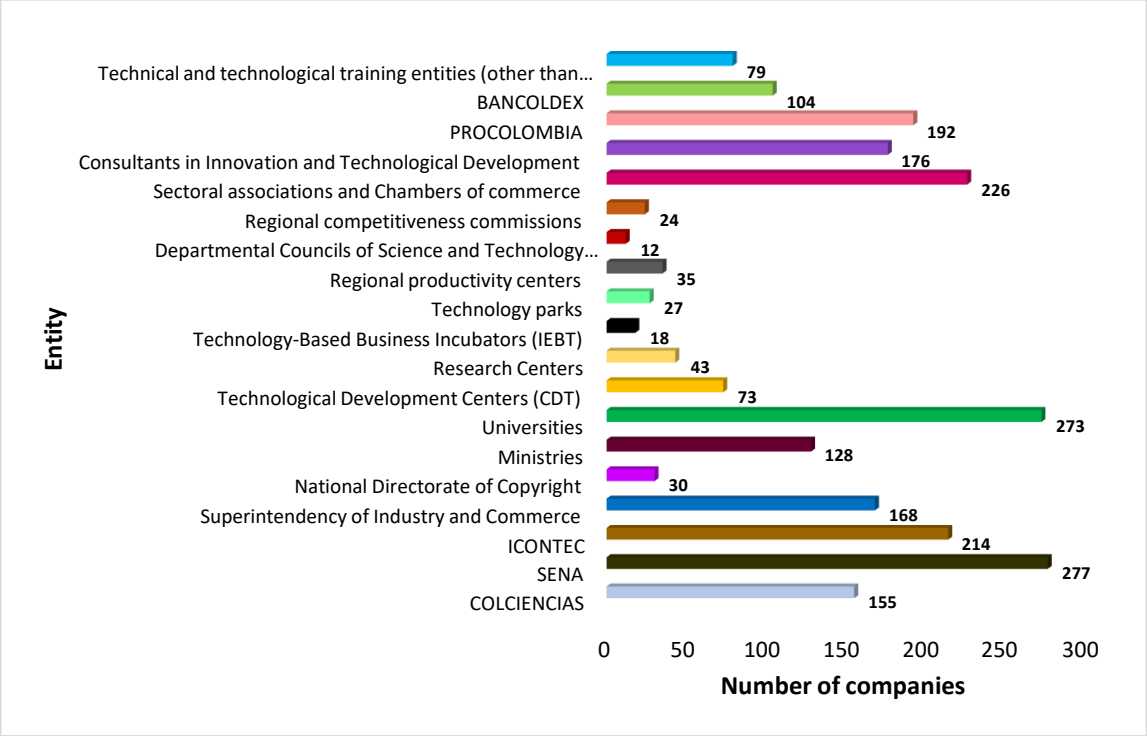
Figure 57. External sources of technological innovation ideas obtained by Innovative, Potentially Innovative companies and companies that intended to innovate.



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

-Support relationship with entities of the National System of Science, Technology and Innovation: Figure 58 evidences that the highest number of innovative companies, potentially innovative and with intention to innovate have a support relationship with SENA and Universities to carry out Scientific, Technological and Innovation activities. (See Data analysis Excel File - C.5.3. Sheet).

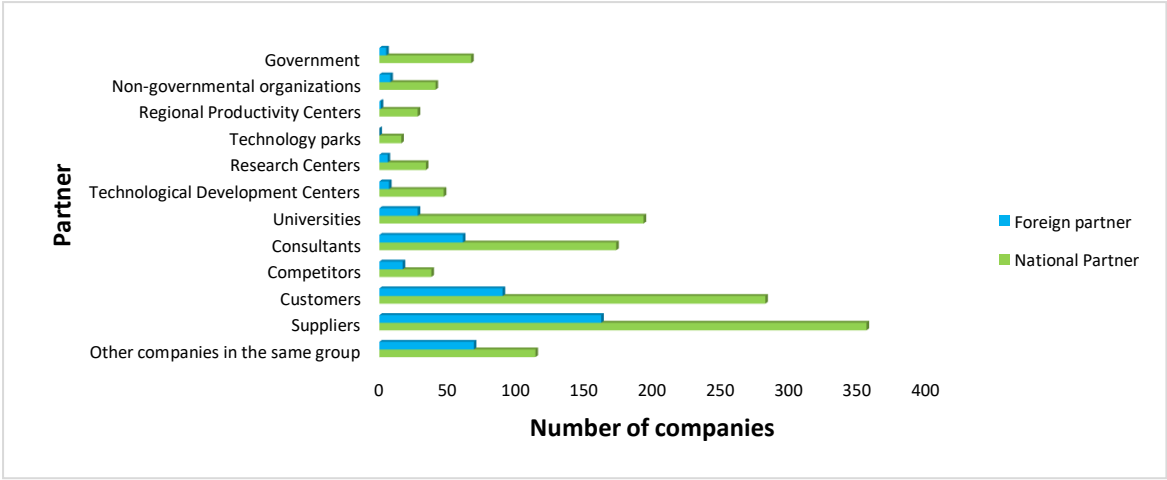
Figure 58. Distribution of companies with respect to the entities with which have a support relationship to carry out Scientific, Technological and Innovation activities.



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

- Partners to carry out Scientific, Technological and Innovation activities: Figure 59 shows that the highest number of innovative and potentially innovative companies have a cooperation relationship with *National Suppliers*, *National Customers* and *National Universities.* (See Data analysis Excel File - C.5.4. Sheet).

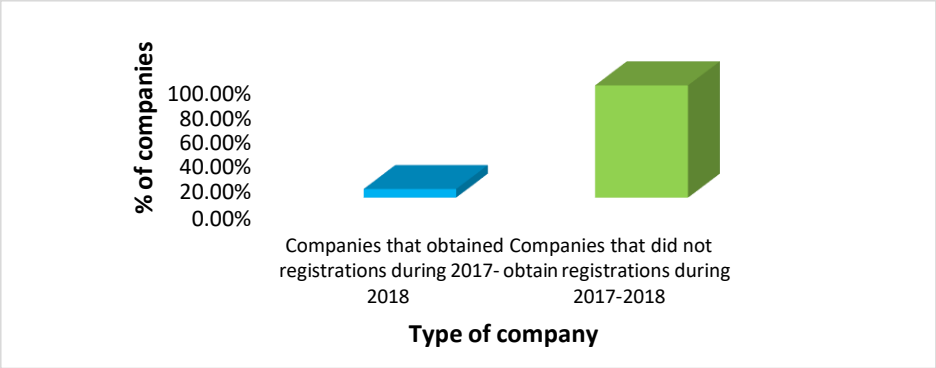
Figure 59. Distribution of companies with respect to the partners with which have a cooperation relationship to carry out Scientific, Technological and Innovation activities.



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

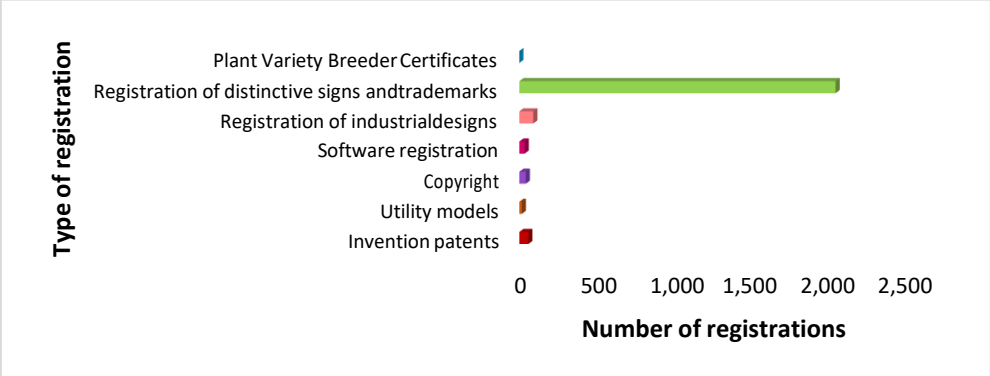
- Registrations of intellectual property protection: Figure 60 evidences that most companies did not obtain registrations during 2017-2018, it is 92,89% of the total numberof companies. And, Figure 61 shows that the largest number of intellectual property protection registrations obtained by the investigated companies is associated with *Registration of distinctive signs and trademarks.* (See Data analysis Excel File - C.6.1. Sheet).

Figure 60. Distribution of companies with respect to registrations of intellectual property protection



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

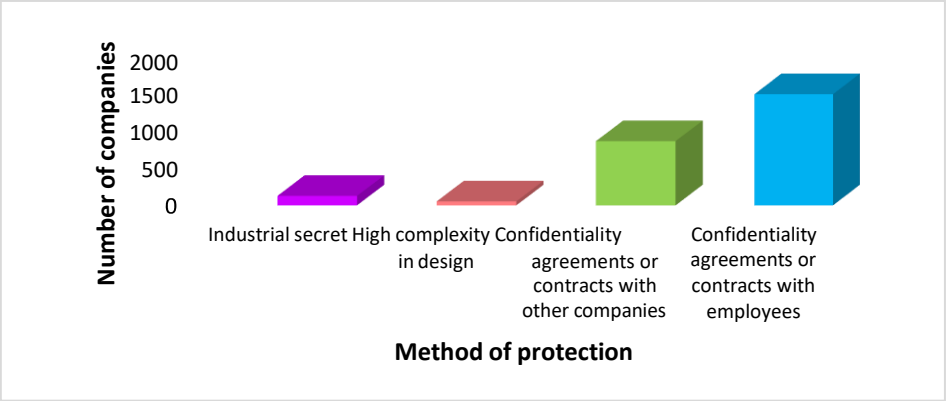
Figure 61. Number of registrations of intellectual property protection by type



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

-Other methods of intellectual property protection: 23,66% of the total number of companies preferred to use other methods to protect their intellectual property protection (See Data Analysis C.6.2). On the other hand, by looking at Figure 62, we can conclude that most companies used *Confidentiality agreements or contracts with employees*, followed by *Confidentiality agreements or contracts with other companies.* (See Data analysis Excel File - C.6.2. Sheet).

Figure 62. Number of companies that use other methods of intellectual property protection.



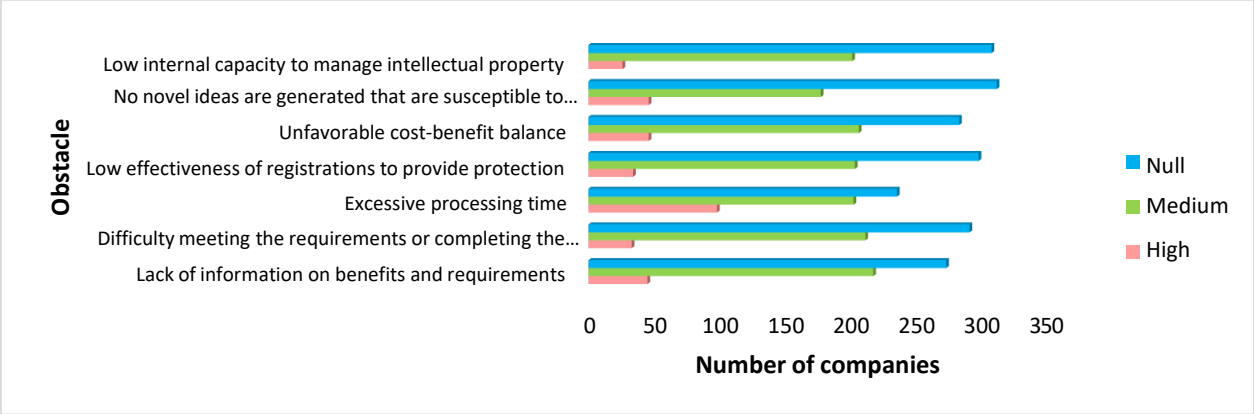
Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

-Importance of obstacles to obtain intellectual property registrations by companies that accessed to them: Figure 63 depicts the level of importance given by the industrial companies to the different types of obstacle:

- ✓ *Lack of information on benefits and requirements* was rated with null importance by most industrial companies (51,03%).
- ✓ *Difficulty meeting the requirements or completing the paperwork* was considered of null importance by the greatest portion of the industrial companies (54,39%)
- ✓ *Excessive processing time* was given null importance by the greatest portion of the industrial companies that intended to access public resources (43,93%).
- ✓ *Low effectiveness of registrations to provide protection* was rated with null importance by most industrial companies (55,70%)
- ✓ *Unfavorable cost-benefit balance* was given null importance by the greatest portion of the industrial companies that intended to access public resources (52,90%).
- ✓ *No novel ideas are generated that are susceptible to obtaining registrations* was considered with null importance by the highest number of industrial companies that intended to access public resources (58,32%).
- ✓ *Low internal capacity to manage intellectual property* was classified with null importance by the 57,57% of the industrial companies that obtained these registrations.

In this vein, all obstacles were rated with low importance, which means that although there are obstacles to obtain intellectual property registrations, they are not that important to industrial companies. (See Data analysis Excel File - C.6.3. Sheet).

Figure 63. Importance of obstacles to obtain intellectual property registrations by companies that obtained these registrations.



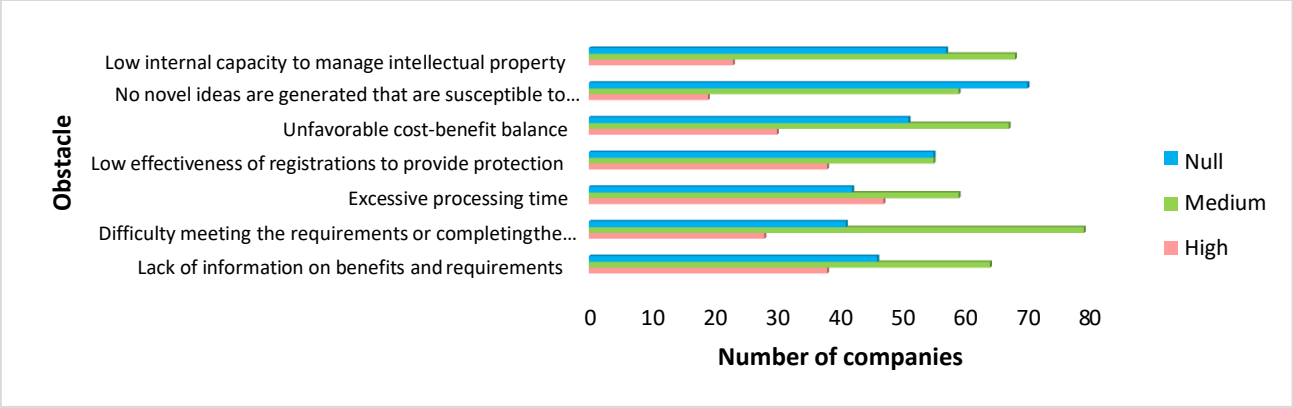
Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

-Importance of obstacles to obtain intellectual property registrations by companies that intended to obtain such registrations: Looking at Figure 64, it is possible to conclude the level of importance given by the industrial companies to the different types of obstacle:

- ✓ *Lack of information on benefits and requirements* was considered of medium importance by the greatest portion of the industrial companies (43,24%)
- ✓ *Difficulty meeting the requirements or completing the* paperwork was rated with medium importance by most industrial companies (53,38%).
- ✓ *Excessive processing time* was given medium importance by the highest percentage of industrial companies that intended to obtain such registrations (39,86%).
- ✓ *Low effectiveness of registrations to provide protection* was considered with medium importance and at the same time with null importance by the highest number of industrial companies that intended to obtain registrations (37,16%).
- ✓ *Unfavorable cost-benefit balance* was rated with medium importance by most industrial companies (45,27%)
- ✓ *No novel ideas are generated that are susceptible to obtaining registrations* was given null importance by the greatest portion of the industrial companies that intended to obtain intellectual property registrations. (47,30%).
- ✓ *Low internal capacity to manage intellectual property* was classified by the highest number of companies (45,95% of those that intended to obtain registrations) as an obstacle of medium importance.

Unlike the case of industrial companies that obtained intellectual property registrations, almost all obstacles were classified with medium importance except *No novel ideas are generated that are susceptible to obtaining registrations*, which was rated as an obstacle of null importance in both cases. (See Data analysis Excel File - C.6.4. Sheet)

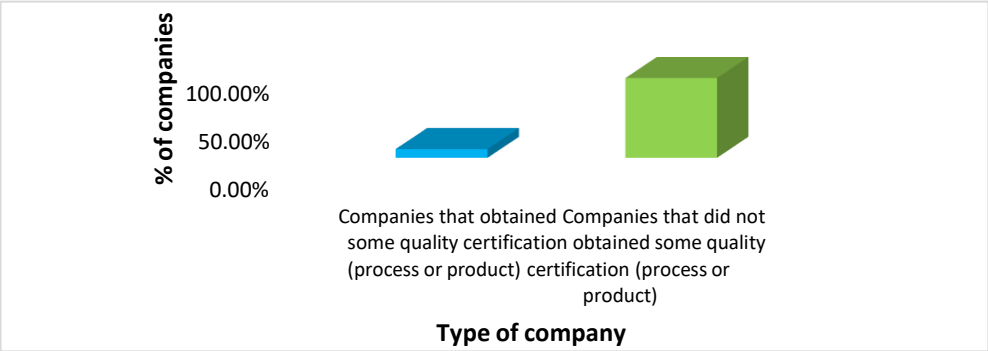
Figure 64. Importance of obstacles to obtain intellectual property registrations by companies that intended to obtain such registrations.



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

-Quality certifications of product and/or process: Figure 65 evidences that only a small part of the companies (9,84%) obtained some quality certification of process or product for the reference period. On the other hand, Figure 66 shows that most industrial companies obtained process quality certifications. (See Data analysis Excel File - C.6.5. Sheet).

Figure 65. Classification of companies with respect to the fact of having quality certifications.



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

Figure 66. Classification of companies by quality certifications type

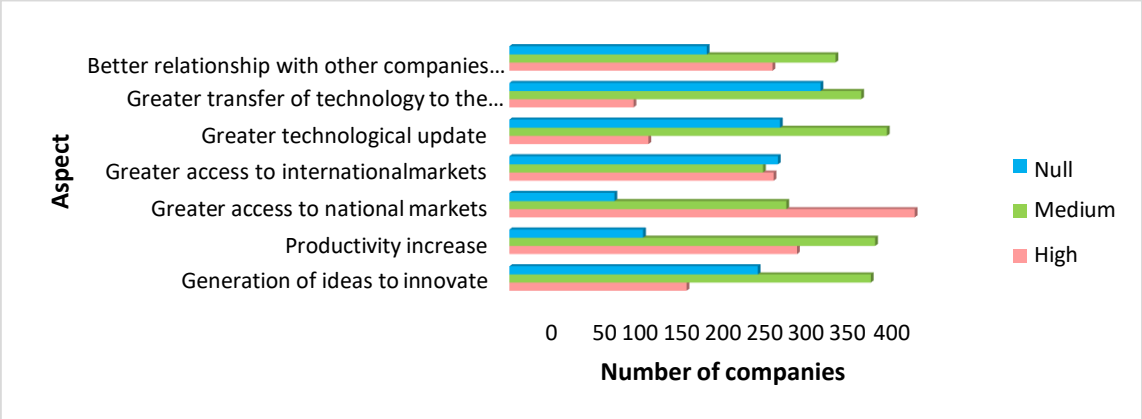
Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

Looking at Figure 67, it is possible to conclude the level of importance given by the industrial companies to the different aspects of obtaining quality certifications:

- ✓ *Generation of ideas to innovate* was considered of medium importance by the greatest portion of the industrial companies that obtained some qualitycertification (45,88%)
- ✓ *Productivity increase* was rated with medium importance by most industrial companies (46,42%).
- ✓ *Greater access to national markets* was given high importance by the highest percentage of industrial companies that obtained some quality certification (51,42%).
- ✓ *Greater access to international markets* was considered with null importance by the highest number of industrial companies (34,14%).
- ✓ *Greater technological update* was rated with medium importance by most industrial companies (47,91%)
- ✓ *Greater transfer of technology to the company* was given medium importance by the greatest portion of the industrial companies (44,67%).
- ✓ *Better relationship with other companies in the sector* was classified by the highest number of companies (41,43% of those that obtained some quality certification) as an aspect of medium importance.

In this vein, the aspect that was considered as the most important when obtaining some quality certification was *Greater access to national markets.* (See Data analysis Excel File- C.6.5. Sheet).

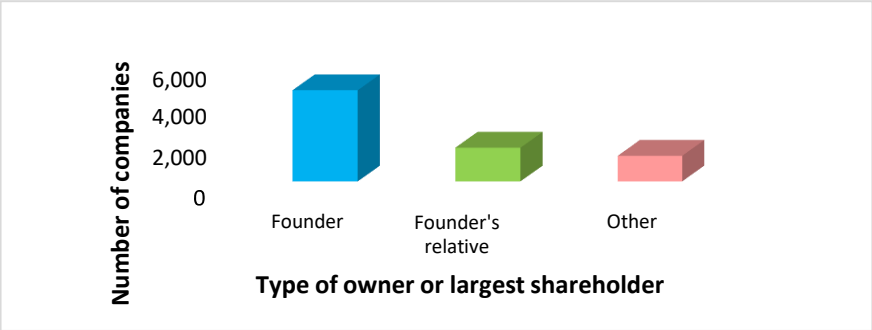
Figure 67. Importance of aspects of obtaining quality certifications.



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

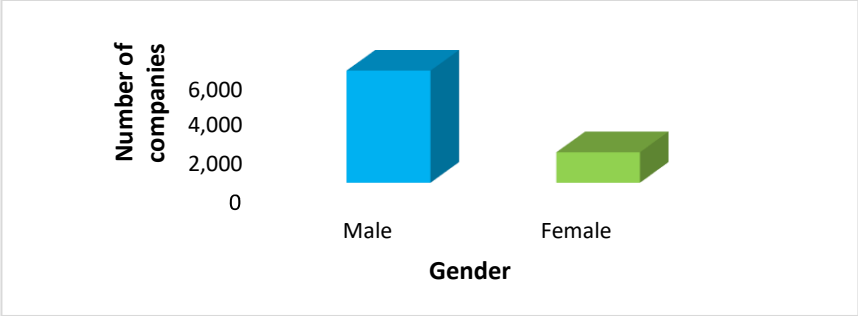
-Type of owner of largest shareholder: According to Figure 68, we can conclude that most companies have the founder as owner or largest shareholder of the firm (60,50%). And Figure 69 shows that the greater portion of industrial companies (78,63%) have a male manager. (See Data analysis Excel File- C.7.1. Sheet)

Figure 68. Type of owner or largest shareholder.



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

Figure 69. Gender of the manager of the company



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

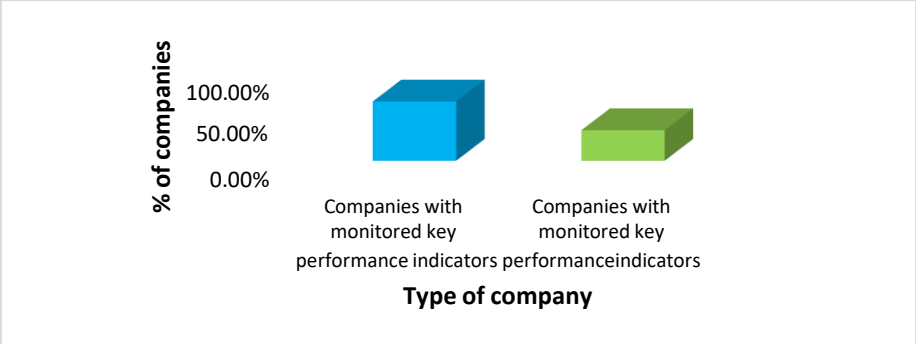
-Response mechanisms to production problems: By looking at Figure 70, we can state that most companies (45,38%) reacted by fixing the production processes problems, actions were taken to ensure that it did not happen again, and a process of continuous improvement was started to anticipate such problems. (See Data analysis Excel File - C.7.1. Sheet)

Figure 70. Answer to production processes problems.

Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

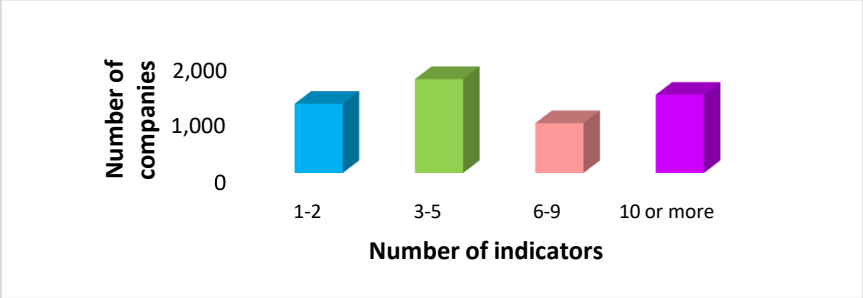
-Key performance indicators: Figure 71 shows that most companies (66%) handle monitored key performance indicators. In turn, Figure 72 evidences that the greater part of the industrial companies (32,24%) have between 3 and 5 key performance indicators monitored. (See Data analysis Excel File - C.7.2. Sheet).

Figure 71. Type of companies with respect to indicators monitoring.



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

Figure 72. Number of key performance indicators monitored by companies



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

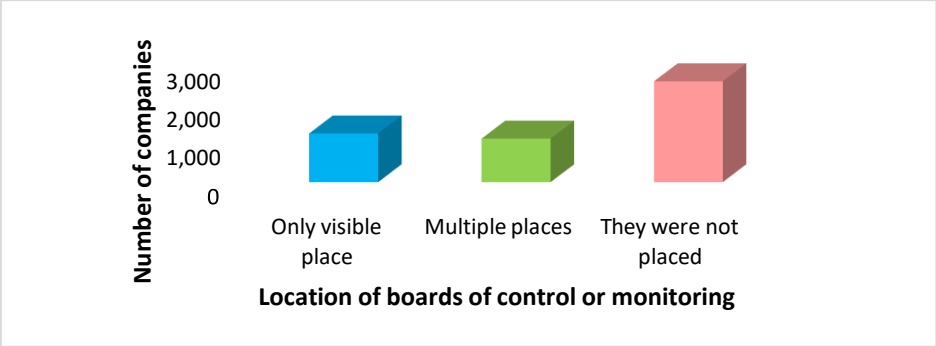
Figure 73 shows that in most cases, the key performance indicators of industrial companies are reviewed monthly by managers. (See Data analysis Excel File - C.7.2. Sheet).

Figure 73. Staff assigned to monitoring indicators and review frequency.

Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

Finally, according to Figure 74, most industrial companies (52,24%) did not placed location of boards of control or monitoring. (See Data analysis Excel File - C.7.2. Sheet).

Figure 74. Location of boards of control or monitoring



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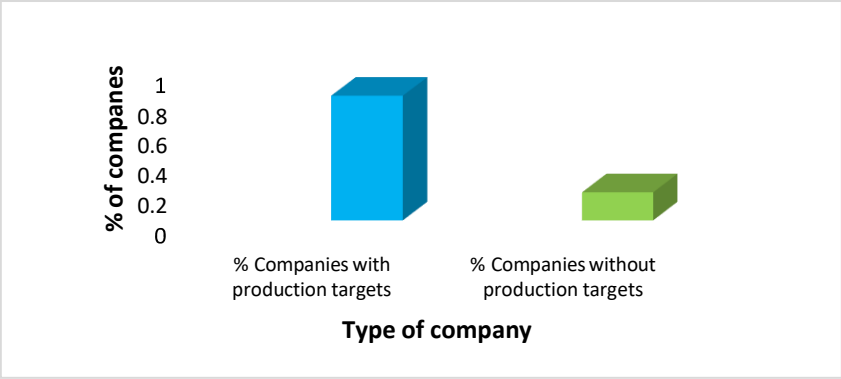
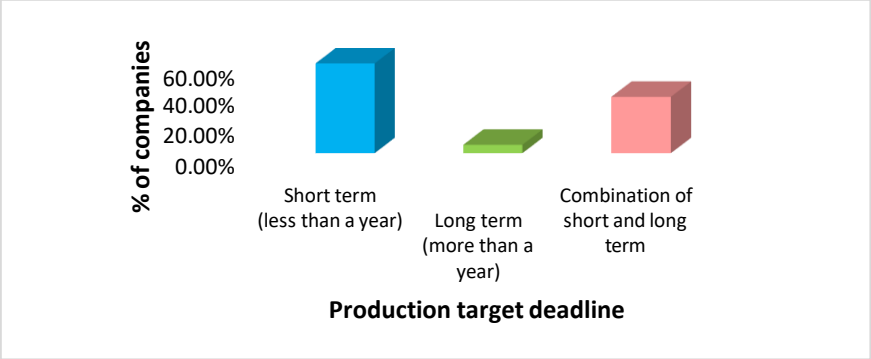
-Production targets: Figure 75 shows that most industrial companies (81,66%) handle production targets. While Figure 76 evidences that most of them, 58,12%, have short term (less than a year) production targets. (See Data analysis Excel File - C.7.3. Sheet).

Figure 75. Type of companies with respect to production targets



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

Figure 76. Type of production targets deadlines

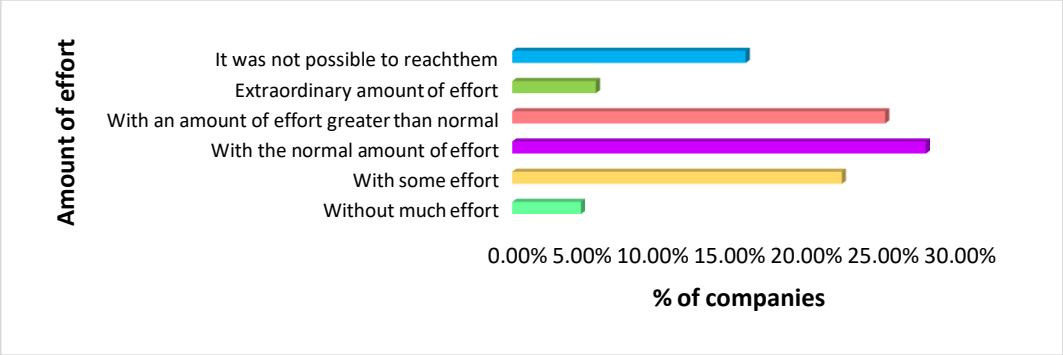


Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

On the other hand, Figure 77 depicts the amount of effort to achieve production goals by

industrial companies and we can conclude that most of industrial companies (27,55%) are characterized by a normal amount of effort. (See Data analysis Excel File - C.7.3. Sheet).

Figure 77. Type of companies according to efforts to achieve production goals.



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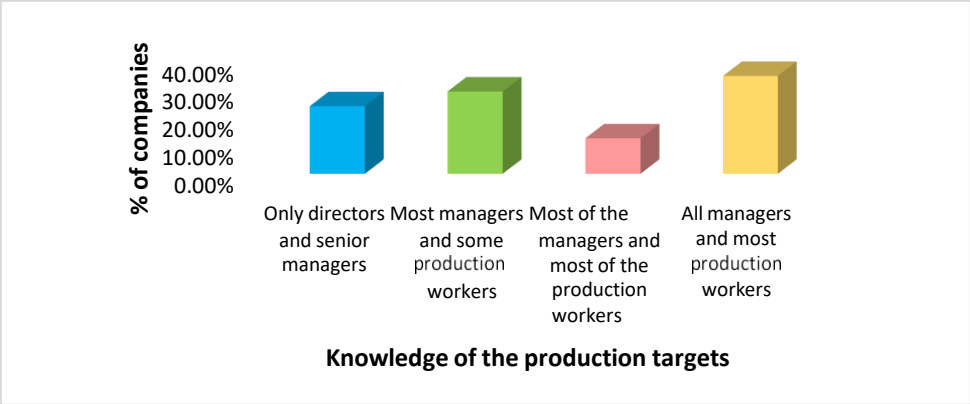
Finally, according to Figure 78, the production targets are known *by all managers and most production workers* in most industrial companies (34,55%). (See Data analysis Excel File - C.7.3. Sheet).

Figure 78. Types of company according to the knowledge of the production targets



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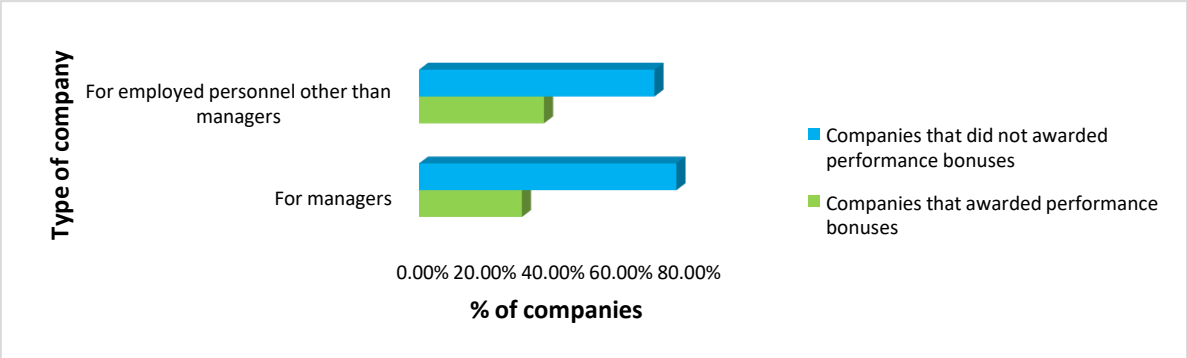
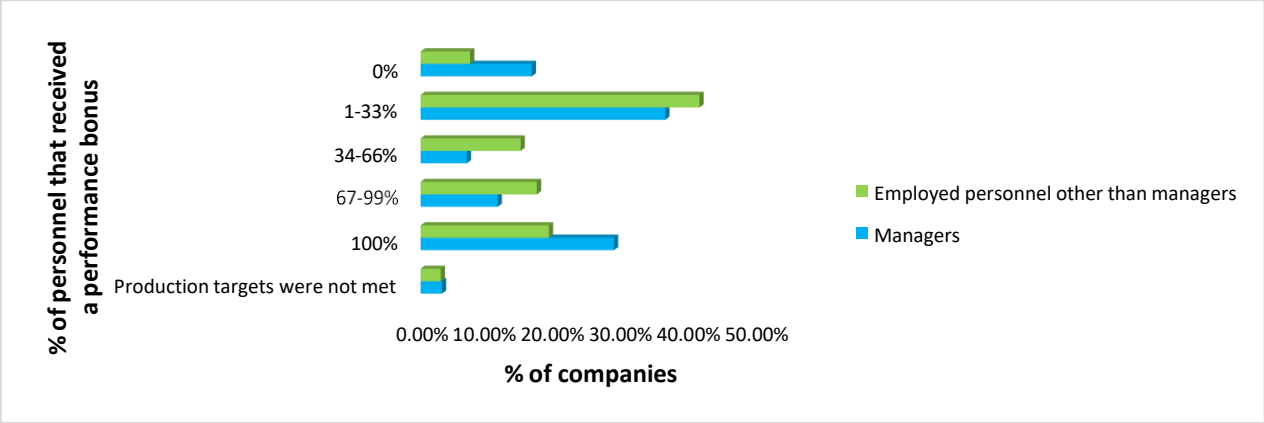
-Performance bonus: Looking at Figure 79, it is possible to state that most companies did not awarded performance bonuses. And Figure 80 shows that for the case of *Employed personnel other than managers*, in most companies (40,28%), the personnel that received a performance bonus was between 1% and 33% while for the case of *Managers*, the result is the same because in most companies (35,27%) the personnel that received a performance bonus was between 1% and 33%. These outcomes were followed by the 100% of employees that were awarded a performance bonus in industrial companies: 27,86% for *Managers* and 18,50% for *Employed personnel other than managers.* (See Data analysis Excel File - C.7.4. Sheet)

Figure 79. Type of companies with respect to performance bonuses



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

Figure 80. Personnel that received a performance bonus



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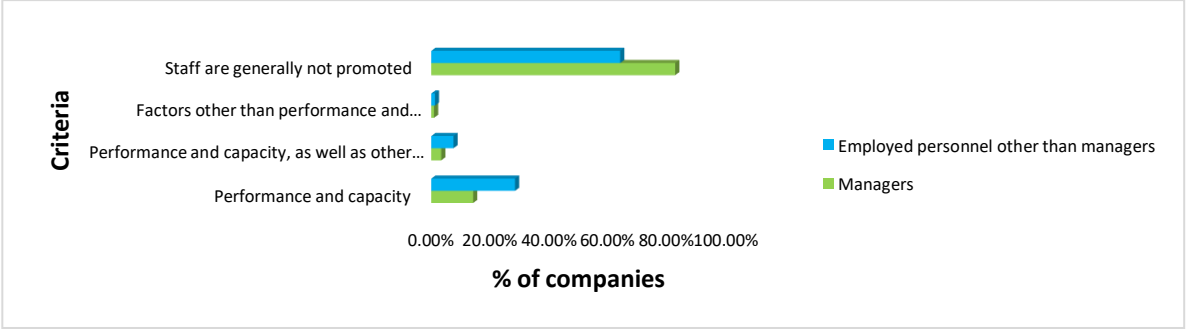
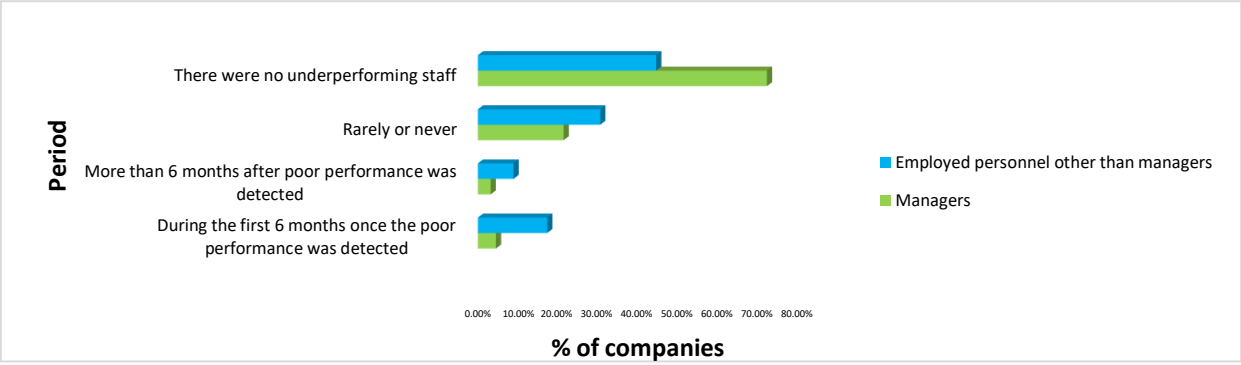
Promotion criteria and time of reassignment or dismissal due to poor performance: Figure 81 shows that in most companies, staff are generally not promoted (81,71% for the case of *Managers* and 63,28% for *Employed personnel other than managers*). And, according to Figure 82, we can state that in most companies, there were no underperforming staff (71,26% for the case of *Managers* and 43,95% for *Employed personnel other than managers*). (See Data analysis Excel File - C.7.5. Sheet).

Figure 81. Criteria by which company personnel are promoted.



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

Figure 82. Period in which employed personnel are reassigned or fired for poor performance.



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2.2. Econometric analysis

To explore the association between a specific source of financing and the type of asset created with it, considering the influence of other variables that may affect this degree of association[4], a multiple regression model was proposed.

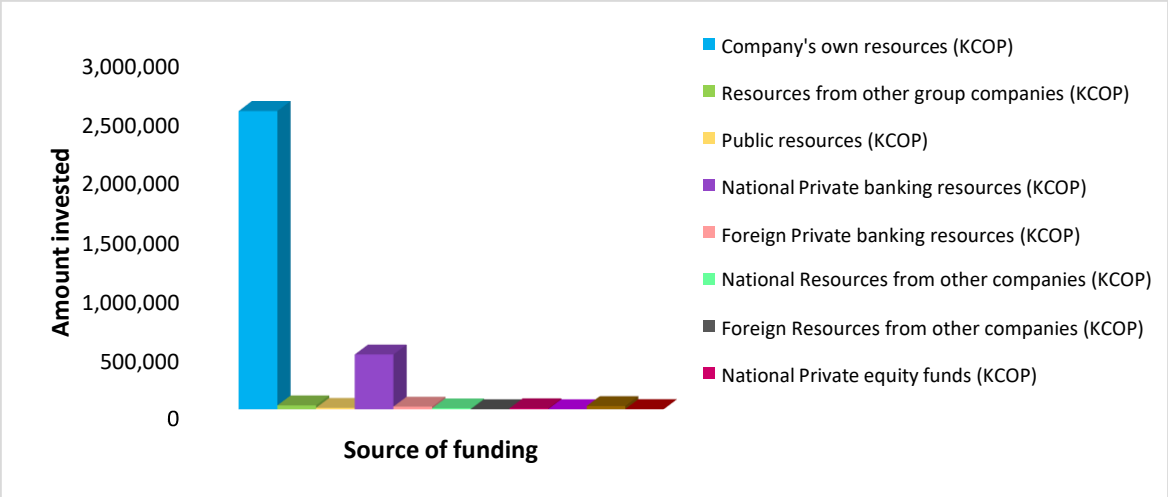
2.2.1. Variables that can affect the relative importance of the main specific sources of financing used to finance investments in innovation. Multivariate analysis.

Independent variables that may affect the response variable were selected, taking into account the DANE database and the literature review.

- ✓ Investment in Internal R&D Activities
- ✓ Investment in External R&D Activities
- ✓ Investment in Machinery and Equipment
- ✓ Investment in Information and Communication Technologies
- ✓ Investment in Marketing
- ✓ Investment in Technology transfer and / or acquisition of another knowledge
- ✓ Investment in Technical assistance and consulting
- ✓ Investment in Engineering and Industrial Design
- ✓ Investment in Training and Qualification
- ✓ Investment in Biotechnology
- ✓ Size of the firm (number of employees in Scientific, Technological and Innovation activities)
- ✓ Investment in innovation of new goods or services
- ✓ Investment in innovation of improved goods or services
- ✓ Type of innovation
- ✓ Type of contracts
- ✓ Type of capital
- ✓ Type of public sector for product innovations
- ✓ Type of consulting agents
- ✓ The use of private banking resources
- ✓ The use of private equity funds

As the idea is to find a relationship between the sources of financing with which firms fund its innovations and the previous independent variables. The response variable was chosen according to Figure 83, that shows that the Company's own resources is the most used one.

Figure 83. Amount of money invested in Scientific, Technological and Innovationactivities by funding source.



Source: DANE, Technological Development and Innovation Survey – EDIT - Own creation

2.2.2 Multiple regression model

2.2.2.1. Create a regression model: According to the database provided by the DANE, a regression model was proposed to analyze the relationship between the *investment from Company's own resources* and other variables that are named below:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \beta_{11} X_{11} + \beta_{12} X_{12} + \beta_{13} X_{13} + \beta_{14} X_{14} + \beta_{15} X_{15} + \beta_{16} X_{16} + \beta_{17} X_{17} + \beta_{18} X_{18} + \beta_{19} X_{19} + \beta_{20} X_{20} + \beta_{21} X_{21} + \beta_{22} X_{22} + \beta_{23} X_{23} + \beta_{24} X_{24} + \beta_{25} X_{25} + \beta_{26} X_{26} + \epsilon \quad (3)$$

The multiple regression model (3), exposed previously, was applied to the study of the source of financing that was the most important according to the percentage of financing they represented: *Company's own resources* with 81,41% of the total resources invested.

Where:

Y: percentage of investment from company's own resources

X_1: Percentage of investment in innovation made in internal R&D activities.

X_2: : Percentage of investment in innovation made in the acquisition of external R&D.

X_3: Percentage of investment in innovation made in the acquisition of machinery and equipment.

X_4: Percentage of investment in innovation made in Information and communication technologies.

X_5 : Percentage of investment in innovation made in marketing.

X_6: Percentage of investment in innovation made in Technology transfer and / or acquisition of another knowledge.

X_7: Percentage of investment in innovation made in Technical assistance and consulting.

X_8: Percentage of investment in innovation made in Engineering and industrial design.

X_9: Percentage of investment in innovation made in Training and qualification.

X_{10}: Percentage of investment in innovation made in Biotechnology.

X_{11}: Size of the company. (The number of employees as an indicator of size).

X_{12} : Percentage of the investment in Innovation in new goods or services.

X_{13}: Percentage of the investment in Innovation in significantly improved goods or services.

X_{14}, X_{15}: Dummy variables for type of innovation.

X_{14} : :was assigned 1 if the company classifies the innovation as broad and 0 in any other case.

X_{15}: was assigned 1 if the company classifies the innovation as strict, and 0 in any other case.

X_{16}: Dummy variable for type of contract

X_{16}: was assigned 1 if the company had contracts with the foreign public sector, and 0 in any other case.

X_{17}: Dummy variable for type of equity ownership

X_{17}: was assigned 1 if it is reported that the company has foreign investment within its social capital, and 0 in any other case.

X_{18}, X_{19}: Dummy variable according to supplied product innovations.

X_{18}: was assigned 1 if the company supplied product innovations to the national public sector, and 0 in any other case.

X_{19}: was assigned 1 if the company supplied product innovations to the foreign public sector, and 0 in any other case.

X_{20}: Dummy variable according to hiring of external consulting agents.

X_{20}: was assigned 1 if it is reported that the company hired external consulting agents.

X_{21}: Percentage of the investment from resources of other group companies

X_{22}: Percentage of the investment from public resources

X_{23}: Percentage of the investment from Private Banking

X_{24}: Percentage of the investment from other companies' resources

X_{25}: Percentage of the investment from Private equity funds

X_{26}: Percentage of the investment from Cooperation resources or donations

ϵ: random variable that represents the error term.

2.2.2.2. Verify the normality of the response variable (dependent variable): By implementing statistical software R, the following steps were carried out.

Different tests were used to check if the data of the dependent variable follow a normal distribution:

- ✓ Shapiro-Wilk normality Test
- ✓ Jarque Bera Test
- ✓ Anderson-Darling normality Test

And the hypotheses are:

$$H_0: The\ data\ follow\ a\ normal\ distribution$$

$$H_1: The\ data\ don't\ follow\ a\ normal\ distribution$$

To verify these statistical hypotheses, 0.05 has been determined as the significance level and it will be compared with the p-value. If the p-value is less than the alpha significance level, then the null hypothesis is rejected.

The results of the tests are shown below. Figure 84 and Table 3 indicate that there is sufficient evidence to reject the null hypothesis, then the data don't follow a normal distribution because all values were lower than 0.05.

Figure 84. Tests results of the response variable.

```
> shapiro.test(Y1)

        Shapiro-Wilk normality test

data:  Y1
W = 0.8437, p-value = 9.283e-05

> jarque.bera.test(Y1)

        Jarque Bera Test

data:  Y1
X-squared = 21.501, df = 2, p-value = 2.144e-05

> ad.test(Y1)

        Anderson-Darling normality test

data:  Y1
A = 1.7677, p-value = 0.0001294
```

Table 3. Tests results summary of the response Variable.

Normality Test name	Shapiro-Wilk	Jarque-Bera	Anderson-Darling
Reference Value-p	0.05	0.05	0.05
Test result	9.283e-05	2.144e-05	0.0001294

Also, graphical methods were used to verify whether the data of the dependent variable follow a normal distribution or not.

- ✓ Histogram
- ✓ Box Plot
- ✓ Quantile-quantile (q-q) Plot

Figure 85, Figure 86 and Figure 87 are consistent with the tests results due to normality is not observed. In particular, Figure 87 shows some outliers that cannot be removed because they are not due to an error when building the database or measuring the variable. Eliminating or replacing them can modify the inferences made from that information, since it introduces a bias, decreases the sample size and can affect both the distribution and the variances.

Figure 85. Histogram of the dependent variable

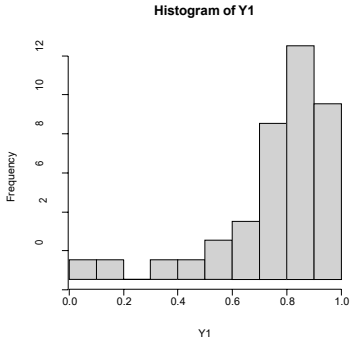


Figure 86. Box Plot of the dependent variable

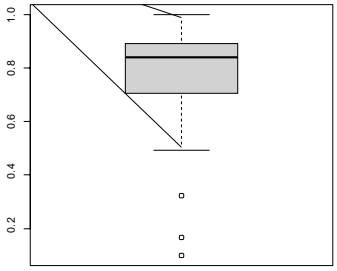
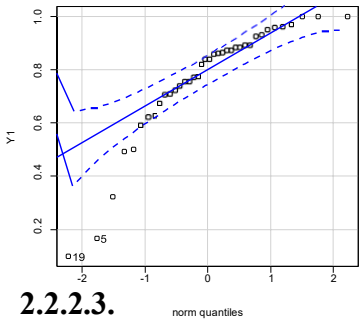


Figure 87. Quantile-quantile (q-q) plot



2.2.2.3.

2.2.2.4. Find the power to which the dependent variable must be raised to obtain a normal distribution: Given that the response variable does not follow a normal distribution, the *powerTransform* function was used to "normalize" the variable. Figure 88 indicates the required power for the variable to become normal.

Figure 88. powerTransform

```
> powerTransform(Y1)
Estimated transformation parameter
      Y1
2.360518
```

Considering interpretarion issues, it is important to use a whole number, so we prove the normality of the response variable with the power 2 and power 3.

✓ **Transformed dependent variable (with power 2)**

The following hypotheses are verified to conclude the normality of the response variable with power 2:

$$H_0: The\ data\ follow\ a\ normal\ distribution$$

$$H_1: The\ data\ don't\ follow\ a\ normal\ distribution$$

According to the tests, we obtain the following results: Figure 8 and Table 4 show that there is sufficient evidence to reject the null hypothesis because one out of three tests have a value lower than 0.05 and the Anderson-Darling's value is very close to 0.05. Then, one must see the graphical tools to conclude about the outcomes.

Figure 89. Results of the test variable (power 2)

```
> Y1F<-Y1^2
> shapiro.test(Y1F)

        Shapiro-Wilk normality test

data:  Y1F
W = 0.93868, p-value = 0.03797

> jarque.bera.test(Y1F)

        Jarque Bera Test

data:  Y1F
X-squared = 3.212, df = 2, p-value = 0.2007

> ad.test(Y1F)

        Anderson-Darling normality test

data:  Y1F
A = 0.6631, p-value = 0.07699
```

Table 4. Tests results summary of the response transformed response variable (power 2)

Normality Test name	Shapiro-Wilk	Jarque-Bera	Anderson-Darling
Reference Value-p	0.05	0.05	0.05
Test result	0.03797	0.2007	0.07699

And, if we use graphical tools to analyze the normality, we can see that Figure 90, Figure 91 and Figure 92 are consistent with the test results. Histogram shows some degree of normality but the Boxplot and the q-q plot don't represent normality. In particular, Figure 92 allows observing some outliers that cannot be removed because they are not due to an error when building the database or measuring the variable. Eliminating or replacing them can modify the inferences made from that information, since it introduces a bias, decreases the sample size and can affect both the distribution and the variances.

Figure 90. Histogram of the transformed dependent variable (power 2)

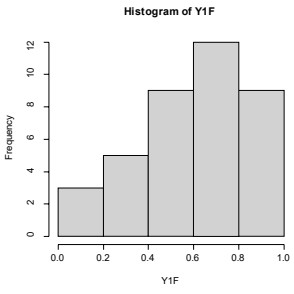


Figure 91. Box Plot of the transformed dependent variable (power 2)

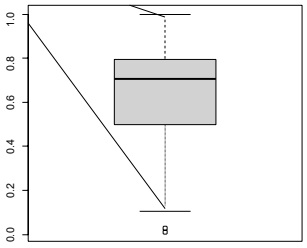
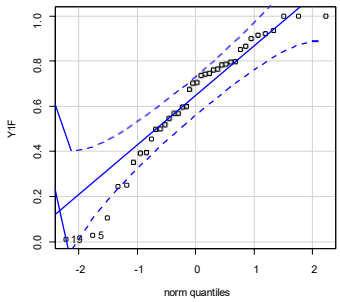


Figure 92. Quantile-Quantile (q-q) Plot of the transformed dependent variable (power 2)



✓ **Transformed dependent variable (with power 3)**

The normality of the response variable with the power 3 is proved taking into account the following hypotheses:

$$H_0: The\ data\ follow\ a\ normal\ distribution$$

$$H_1: The\ data\ don't\ follow\ a\ normal\ distribution$$

By looking at Figure 93 and Table 5, we can conclude that there is no sufficient evidence to reject the null hypothesis because all the tests had a value upper than 0.05.

Then, the data of the response variable follow a normal distribution if we use the power 3.

Figure 93. Results of the test variable (power 3)

```
> Y1F<-Y1^3
> shapiro.test(Y1F)

        Shapiro-Wilk normality test

data:  Y1F
W = 0.9632, p-value = 0.2408

> jarque.bera.test(Y1F)

        Jarque Bera Test

data:  Y1F
X-squared = 1.4988, df = 2, p-value = 0.4726

> ad.test(Y1F)

        Anderson-Darling normality test

data:  Y1F
A = 0.34444, p-value = 0.4684
```

Table 5. Tests results summary of theresponse transformed response variable (power 3)

Normality Test name	Shapiro-Wilk	Jarque-Bera	Anderson-Darling
Reference Value-p	0.05	0.05	0.05
Test result	0.2408	0.4726	0.4684

And, if we use graphical tools to analyze the normality, we can see that Figure 94, Figure 95 and Figure 96 are consistent with the test results.

Figure 94. Histogram of the transformed dependent variable (power 3)

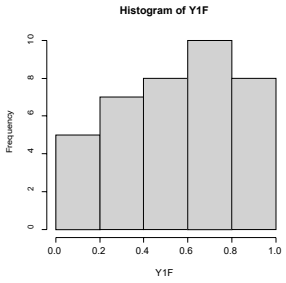


Figure 95. Box Plot of the transformed dependent variable (power 3)

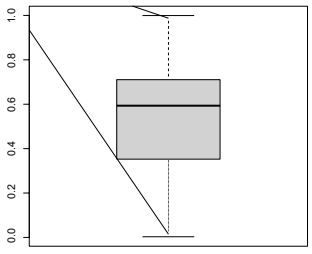
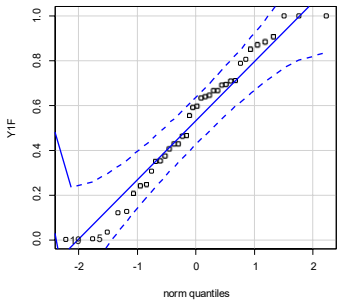


Figure 96. Quantile-Quantile (q-q) Plot of the transformed dependent variable (power 3)



2.2.2.5. Find a significant model: Once the data corresponding to transformed response variable and to the independent variables has been introduced in the statistical software R, a model has been obtained. But its statistical significance must be proved through the following hypotheses:

$$H_0: The\ model\ is\ not\ valid$$
$$H_1: The\ model\ is\ valid$$

In this case, a non-significant model has been obtained because its p- value=0.08912 is larger than 0.05. Then, there is no sufficient evidence to reject the null hypothesis.

Also, it is important to analyze whether the variables are significant to the model, it means evaluating whether the variables are contributing to the model. For that reason, the null hypothesis is verified:

$$H_0: variables\ do\ not\ contribute\ to\ the\ model$$
$$H_1: variables\ contribute\ to\ the\ model$$

By observing Figure 97, one can notice that there are many dependent variables that are not significant in explaining the independent variable, since their p-values are higher than the established significance level of 0.05, then there is no sufficient evidence to reject the null hypothesis for each variable. The only significant variable in this model is X_{25}: Percentage of the investment from Private equity funds.

Figure 97. Model obtained with R software (all the variables)

```
Call:
lm(formula = Y1F ~ X1 + X2 + X3 + X4 + X5 + X6 + X7 + X8 + X9 +
    X10 + X11 + X12 + X13 + X14 + X15 + X16 + X17 + X18 + X19 +
    X20 + X21 + X22 + X23 + X24 + X25 + X26)

Residuals:
     Min       1Q   Median       3Q      Max
-0.39739 -0.05316  0.00010  0.06776  0.22186

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  3.791e+01  1.379e+02   0.275   0.7885
X1          -3.704e+01  1.376e+02  -0.269   0.7928
X2          -3.616e+01  1.364e+02  -0.265   0.7958
X3          -3.741e+01  1.373e+02  -0.272   0.7903
X4          -3.743e+01  1.367e+02  -0.274   0.7893
X5          -3.872e+01  1.382e+02  -0.280   0.7845
X6          -3.669e+01  1.373e+02  -0.267   0.7942
X7          -3.522e+01  1.380e+02  -0.255   0.8032
X8          -3.678e+01  1.373e+02  -0.268   0.7937
X9          -3.517e+01  1.461e+02  -0.241   0.8142
X10          1.183e+01  1.513e+01   0.782   0.4510
X11         -2.358e-04  4.485e-04  -0.526   0.6095
X12         -1.817e-01  1.252e+00  -0.145   0.8873
X13         -3.509e-01  6.379e-01  -0.550   0.5933
X14          1.108e-01  4.074e-01   0.272   0.7907
X15         -5.309e-02  2.625e-01  -0.202   0.8434
X16         -1.376e-01  1.562e-01  -0.880   0.3974
X17          9.575e-02  4.054e-01   0.236   0.8176
X18          6.119e-02  2.771e-01   0.221   0.8293
X19          1.758e-01  2.063e-01   0.852   0.4121
X20          1.373e-01  2.755e-01   0.498   0.6280
X21         -8.754e-01  7.365e-01  -1.189   0.2597
X22         -3.531e+00  3.055e+00  -1.156   0.2722
X23         -4.554e-01  5.099e-01  -0.893   0.3909
X24          4.699e+00  6.974e+00   0.674   0.5143
X25         -7.985e+00  3.200e+00  -2.495   0.0298 *
X26         -4.946e+00  2.736e+01  -0.181   0.8598
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.2131 on 11 degrees of freedom
Multiple R-squared:  0.8369,    Adjusted R-squared:  0.4515
F-statistic: 2.171 on 26 and 11 DF,  p-value: 0.08912
```

Table 6. P-value of the dependent variables

Variable	p-value	Variable	p-value
X_1	0.7928	X_{14}	0.7907
X_2	0.7958	X_{15}	0.8434
X_3	0.7903	X_{16}	0.3974
X_4	0.7893	X_{17}	0.8176
X_5	0.7845	X_{18}	0.8293
X_6	0.7942	X_{19}	0.4121
X_7	0.8032	X_{20}	0.6280
X_8	0.7937	X_{21}	0.2597
X_9	0.8142	X_{22}	0.2722
X_{10}	0.4510	X_{23}	0.3909
X_{11}	0.6095	X_{24}	0.5143
X_{12}	0.8873	X_{25}	0.0298*
X_{13}	0.5933	X_{26}	0.8598

Then, it was necessary to remove and to transform the variables with the highest p-values (the less significative ones). In this way, a step-by-step backward regression procedure was

used and it was possible to obtain the model shown by Figure 98 with all significant variables and with an Adjusted R-squared equal to 0.6682 even better than the first model, it means that 66.82% of the variability of the percentage of use of the company's own resources is predicted by this model, taking into account seven predictive variables.

Figure 98. Model obtained with dependent variables

```
> modelo1 <- lm(Y1F ~X3+X5+X11F+X12+X13+X23+X25)
> summary(modelo1)

Call:
lm(formula = Y1F ~ X3 + X5 + X11F + X12 + X13 + X23 + X25)

Residuals:
     Min       1Q   Median       3Q      Max
-0.43753 -0.11009  0.01230  0.07413  0.28484

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  1.13125    0.25349   4.463 0.000106 ***
X3          -0.45874    0.14683  -3.124 0.003932 **
X5          -1.58080    0.51956  -3.043 0.004841 **
X11F         0.07191    0.03035   2.370 0.024441 *
X12         -0.72670    0.20829  -3.489 0.001521 **
X13         -0.40444    0.19658  -2.057 0.048431 *
X23         -0.64180    0.17185  -3.735 0.000787 ***
X25         -6.56221    1.65097  -3.975 0.000409 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.1657 on 30 degrees of freedom
Multiple R-squared:  0.731,     Adjusted R-squared:  0.6682
F-statistic: 11.65 on 7 and 30 DF,  p-value: 4.664e-07
```

Table 7. P-values of significant variables) R software (significant

Variable	p-value
X_3	0.003932**
X_5	0.004841**
LogX_{11}	0.024441*
X_{12}	0.001521**
X_{13}	0.048431*
X_{23}	0.000787***
X_{25}	0.000409***

2.2.2.6. Verify the non-multicollinearity between the dependent variables of the model:

According to Figure 99, it is possible to conclude that there is no a high degree of multicollinearity between the variables because all of them show a value that is lower than 5. Then, multicollineality is not present in this model.

Figure 99. Model's VIF

```
> vif(modelo1)
      X3       X5     X11F      X12      X13      X23      X25
1.680994 1.189529 1.199883 1.662880 1.834950 1.360694 1.050146
```

2.2.2.7. Validation of the model through residuals

In this section, an analysis of the residuals' normality, homocedasticity and Independence is carried out.

✓ **Normality**

By looking at Figure 100 and Table 8, one can observe that the residuals follow a normal distribution since the p-values are larger than the established significance level=0.05. So, there is no sufficient evidence to reject the null hypothesis:

$$H_0: The\ data\ follow\ a\ normal\ distribution$$

$$H_1: The\ data\ don't\ follow\ a\ normal\ distribution$$

Figure 100. Tests results of residuals (normality)

```
> residuales <- residuals(modelo1)
> shapiro.test(residuales)

        Shapiro-Wilk normality test

data:  residuales
W = 0.97066, p-value = 0.4096

> jarque.bera.test(residuales)

        Jarque Bera Test

data:  residuales
X-squared = 1.2873, df = 2, p-value = 0.5254

> ad.test(residuales)

        Anderson-Darling normality test

data:  residuales
A = 0.34335, p-value = 0.4712
```

Table 8. Tests results summary ofresiduals (normality)

Normality Test name	Shapiro-Wilk	Jarque-Bera	Anderson-Darling
Reference Value-p	0.05	0.05	0.05
Test result	0.4096	0.5254	0.4712

✓ **Homocedasticity**

By looking at Figure 104, one can observe that there is no sufficient evidence to reject the null hypothesis since the p-value (0.06315) is larger than the established significance level=0.05. So, the residuals satisfy the assumption of constant variance.

$$H_0: The\ data\ are\ homocedastic$$

$$H_1: The\ data\ are\ heterocedastic$$

Figure 101. Test result of residuals (homocedasticity)

```
> bptest(Y1F ~X3+X5+X11F+X12+X13+X23+X25)

        studentized Breusch-Pagan test

data:  Y1F ~ X3 + X5 + X11F + X12 + X13 + X23 + X25
BP = 13.39, df = 7, p-value = 0.06315
```

✓ **Independence**

By looking at Figure 107 one can observe that there is no sufficient evidence to reject the null hypothesis since the p-value (0.1167) is larger than the established significance level=0.05. So, the residuals satisfy the assumption of Independence.

$$H_0: Autocorrelation = 0$$
$$H_1: Autocorrelation \neq 0$$

Figure 102. Test result of residuals (Independence)

```
        Durbin-Watson test

data:  modelo1
DW = 2.4874, p-value = 0.1167
alternative hypothesis: true autocorrelation is not 0
```

2.2.2.8. Verification of the statistical significance of the model

For this purpose, ANOVA was used and it was built by using Excel. (See Regression Excel File- ANOVA sheet).

To conclude the statistical significance of the model, two hypotheses are verified:

$$H_0: The\ model\ is\ not\ valid$$

$$H_1: The\ model\ is\ valid$$

By looking at Table 9, it is possible to affirm that the model is statistical significant. This conclusion is obtained by analyzing the F-critical value of the ANOVA, taking it as the probability that our regression model is incorrect and should be discarded then it has to be lower than 0.05 (as close to zero as posible) since it represents the p-value that in this case allows to reject the null hypothesis and it is consistent with the results shown by Figure 98. Statistically speaking, the critical value of F indicates the probability that all coefficients in our regression output are actually zero.

Table 9. ANOVA

ANOVA					
	Degrees of freedom	Sum of squares	Average of squares	F	Value critical of F
Regression	7	2.23826726	0.31975247	11.640515	4.6879E-07
Residuals	30	0.82406782	0.02746893		
Total	37	3.06233508			

3. RESULTS

3.1. Interpretation of the model obtained

$Y^3 = 1.13125 - 0.45874X_3 - 1.58080X_5 + 0.07191logX_{11} - 0.72670X_{12} - 0.404447X_{13} - 0.64180X_{23} - 6.56221X_{25} + \epsilon$ (4)

Where:

Y: percentage of investment from company's own resources

X_3: Percentage of investment in innovation made in the acquisition of machinery and equipment.

X_5 : Percentage of investment in innovation made in marketing.

X_{11}: Size of the company. (The number of employees as an indicator of size).

X_{12} : Percentage of the investment in Innovation in new goods or services.

X_{13}: Percentage of the investment in Innovation in improved goods or services

X_{23}: Percentage of the investment from Private Banking

X_{25}: Percentage of the investment from Private equity funds

ϵ: random variable that represents the error term.

1.13125 is the intercept, which is the expected cube of the use percentage from the company's own resources when all regressors are equal to 0.

X_3: -0.45874 is the expected change in the cube of use percentage from company's own resources when the investment percentage in machinery equipment increases one unit. The negative relationship in the importance of own resources and Investment in machinery and equipment means that when investments in machinery and equipment are high, this is translated into greater availability of assets that can be used as collateral, then external funders will be more willing to finance the investment. This outcome is consistent with the results obtained by Barona, B., et al., (2015). Also, with Hall (2002), Carpenter& Petersen (2002) research and with Casson et al. (2008) who state that debt-holders are willing to lend money when the Project involves subtantial investment in plant and equipment since they secure loans rather than substantial R&D investment.

X_5: -1.5808 means the expected change in the cube of the use percentage from company's own resources when the investment percentage in marketing increases one unit.

X_{11}: 0.07191 must be interpreted as an increase of 1% in the size of the company is associated to a change in the cube of use percentage from the company's own resources in one unit. This result contradicts the literature review because the literature on business financing (Berger and Udell, 1998) suggests that smaller companies only have access to internal financing but as they get older they start to have access to other sources such as bank financing. However, Morales, E. A. M. (2019) research evidences that large companies were the ones that use most frequently internal resources. This outcome can be supported by the Peaking Order Theory, in which innovative companies prefer own resources to finance innovation instead of debt and equity because of the presence of information asymmetries and will look for these external sources only if internal funding is not enough.

X_{12}: -0.72670 is the expected change in the cube of use percentage from company's own resources when the percentage of new goods or services increases one unit. This negative relationship can be since creating new products and/or services may require large financial resources, then, companies tend to look for external financing. Nevertheless, the literature review in this topic is contradictory: Hall & Lerner (2009) and Hall et al. (2016), suggests that innovative firms strongly use internal resources as a main financial source since innovation is riskier and long-term, for that reason, the profit rate required by external investors is large. However, Morales, E.A.M (2019) stresses that innovation activities are costly, therefore, firms must look for money from external funding sources and recognizes that innovative firms could be more active in the search for external funding and could prove to banks their projects could be successfully finished, which allows to have more access to bank funding. On the other hand, Ayyagari et al. (2011) investigated the characteristics of the firms that were associated with conducting innovation activities and found that the access to external finance is associated to a higher degree of innovation by firms and in most cases is

bank funding although liquid equity markets may provide the resources for radical product innovations, but firms use first debt since it involves giving up less control rights than equity and when they have no choice, opt for equity. Finally, statistical analyzes in Zuluaga et al. (2015) show that innovative firms seem to make more intensive use of the source bank loans than non-innovative firms.

X_{13}: -0.404447 is the expected change in the cube of use percentage from company's own resources when the percentage of improved goods or services increases one unit. This negative relationship can be since improving products and/or services may require large financial resources, then, companies tend to look for external financing. This outcome is consistent with Casson et al. (2008) research, which associated the continuous improvements with bank's lending. Also, it can be supported by Morales, E.A.M (2019) and Zuluaga et al. (2015) as in the case of new goods or services. And, finally this negative relationship is another evidence of Ayyagari et al. (2011) research, in which the conclusion was that bank financing (domestic and foreign private banking) was positively associated with the improvement of existing products lines, the opening of a new plant and the signing of joint ventures with foreign partners.

X_{23}: -0.64180 is the expected change in the cube of use percentage from company's own resources when the percentage of investment from private banking resources increases one unit. As expected, the use of own resources and the investment from private banking resources exhibit a negative relationship. Mathematically, the negative relationship may be due to the fact that the variables are expressed in terms of percentages: if the company acquires debt, the financing coming from its own resources decreases. This is consistent with Barona et. Al (2015) research, which found that the relationship between the own resources variable and bank financing turns out to be negative, since companies, in some stages of their life, as their available internal resources increase, could decide to reduce the debt in their financial structure to finance their innovations, considering that equity resources are more suitable as a source of financing than those from bank debt, which are characterized by high interest rates, so the decision is to de-leverage once internal resources have been accumulated in sufficient amounts.

Also, Morales E.A.M (2019) stresses "firms do not use an exclusive funding source, but a combination of them, so a specific company can use internal funding, banks, and government funding at the same time, and all the possible combinations of those sources but the amounts of one decrease those of the other source. In the same sense, a firm's decision to use one of the funding sources can be affected by the likelihood they have access to another funding source."

X_{25}: -6.56221 is the expected change in the cube of use percentage from company's own resources when the percentage of investment from private equity funds increases one unit.

As expected, the use of own resources and the investment from private equity funds have a negative relationship. Mathematically, the negative relationship may be due to the fact that the variables are expressed in terms of percentages: if the company uses equity, the financing coming from its own resources decreases. This negative relationship could suggest a financial structure in which, while the company increases its internal resources, the use of equity decreases, considering that the resources from debt are preferred, since they are characterized by lower risk because of less information asymmetries. This outcome is consistent with Morales E.A.M (2019), who stresses "firms do not use an exclusive funding source, but a combination of them, so a specific company can use internal funding, banks, and government funding at the same time,and all the possible combinations of those sources but the amounts of one decrease those of the other source. In the same sense, a firm's decision to use one of the funding sources can be affected by the likelihood they have access to another funding source."

3.2. Predictions

Considering that at the beginning the data were split into Train data and Test data in order to provide a forecast for values of the independent variables, Table 10 shows the predictions for the train data obtained by Excel (See Regression Excel File – ANOVA Sheet) from the proposed model (4).

Table 10. Predictions obtained for train data.

Observation	Y1F Forecast	Y1F Real	Residuals	Standard residuals
1	0.346	0.355	0.009	0.059
2	0.599	0.638	0.038	0.257
3	0.516	0.642	0.127	0.848
4	0.383	0.426	0.044	0.292
5	0.036	0.005	-0.031	-0.207
6	0.553	0.595	0.041	0.276
7	0.493	0.404	-0.089	-0.596
8	0.397	0.555	0.158	1.058
9	0.485	0.246	-0.239	-1.602
10	0.528	0.805	0.278	1.860
11	0.259	0.352	0.094	0.628
12	0.409	0.306	-0.102	-0.684
13	0.531	0.787	0.256	1.714
14	0.111	0.126	0.015	0.098
15	0.854	1.000	0.146	0.980
16	0.633	0.709	0.076	0.508
17	0.481	0.664	0.183	1.224
18	0.524	0.591	0.067	0.449
19	0.439	0.001	-0.438	-2.937
20	0.848	0.870	0.022	0.147
21	0.355	0.241	-0.114	-0.762

22	0.597	0.881	0.284	1.904
23	0.603	0.458	-0.145	-0.969
24	0.557	0.427	-0.131	-0.875
25	0.595	0.631	0.035	0.237
26	0.952	1.000	0.048	0.322
27	0.841	0.666	-0.175	-1.172
28	0.508	0.692	0.184	1.231
29	0.516	0.375	-0.142	-0.951
30	1.000	1.000	0.000	0.000
31	-0.001	0.034	0.035	0.232
32	0.855	0.853	-0.002	-0.016
33	0.585	0.460	-0.125	-0.835
34	0.917	0.903	-0.014	-0.091
35	0.772	0.705	-0.066	-0.445
36	0.126	0.121	-0.005	-0.032
37	0.839	0.689	-0.150	-1.008
38	0.378	0.208	-0.170	-1.138

Also, Table 11 evidences the predictions for the test data. These predictions were obtained by replacing the data corresponding to dependent variables in the regression model. (See Regression File-Predictions sheet).

Table 11. Predictions for test data

Observation	Y1F Forecast	Y1 Real	Residuals
39	0.126	0.402	0.276
40	0.372	0.468	0.097
41	0.330	0.264	-0.066
42	0.313	0.903	0.590
43	0.408	0.829	0.422
44	0.076	0.783	0.707
45	0.247	0.112	-0.135
46	0.441	1.000	0.558
47	0.297	0.760	0.463
48	-0.267	0.000	0.268

From these predictions, RMSE (Root mean square error) was used. RMSE is a good measure of how accurately the model predicts the response variable by indicating how close the observed data points are to the predicted values of the model. As the square root of a variance, RMSE can be interpreted as the standard deviation of the unexplained variance, and it has the useful property of being in the same units as the response variable. Lower RMSE values indicate a better fit. In this case, RMSE was 23.08% (See Regression File-Predictions sheet).

RMSE is a forecast error measure calculated through the following equation:

$$\sqrt{\frac{1}{N}\sum_{i=1}^{N}(Y_{real} - Y_{predicted})^2} \quad (5)$$

Where:

N: represents the number of observations.
Y_{real}: represents the real values of Y.
$Y_{predicted}$: represents the predicted values of Y.

In this case, the forecast error 23,08% is equivalent to the distance between the predicted values and the real ones.

4. CONCLUSIONS

In this study it was possible to find a statistically significant regression model with a R^2 of 66.82% that explained the relationship between the response variable *Company's own resources* and seven predictor variables that contributed to the model, whose results could be compared with the literature review carried out previously. It is evident that most of the investment in innovation in Colombia, carried out by private sector companies, according to the EDIT IX survey, was concentrated in *Machinery and equipment* whose relative importance was 54.12%, followed by *Internal R&D activities* with 24,68%. Regarding financing, it is possible to observe that the main source of funds used was the *Company's own resources* with 81,41%, followed by *National Private Banking* whose relative importance was 15,07%, these results being compatible with the review of the literature where data from several countries confirm the dominant role of internal resources, but it was also found that banks have participated prominently in financing innovation. In addition, the result regarding the most used public financial support mechanism for 2017 is consistent with the literature review, since the highest financed value was obtained using *BANCOLDEX-INNpulsa-MinComercio* (37%), however, in 2018 the highest amount of money was financed by *COLCIENCIAS (Locomotive of innovation for companies)* with 47% of the total of public resources.

It is also important to analyze the difficulties that companies encountered in accessing external financial resources since the financial restriction generates a limitation to carry out innovation activities and it was possible to find that 50.16% of the companies had D*ifficulties in accessing financing external to the company* and that 52% had as an obstacle *Little information on public support instruments.*

In addition, if the obstacles that the firms involved in STI activities considered as the main obstacles to access public resources are verified, it is highlighted that: i)E*xcessive Processing Time* was considered as an important impediment by 81.68% of the surveyed companies. ii) *Difficulty meeting requirements or completing paperwork* was considered highly relevant by 78.33% of the companies. iii) *Lack of knowledge of existing public financing lines* was classified as highly important by 66.67% of companies.

From this and given that the way in which companies finance their innovation activities not only depends on the characteristics of the organization, but also on the policies of the country in which it is located, because these can favor or hinder said process, it is necessary to establish policies to promote financing lines and public instruments, so that companies are more aware of the sources to which they can resort if they do not have sufficient internal resources to finance their innovation activities. Also, it is necessary to

offer exclusive credits for innovation, with qualified personnel to evaluate and select the projects to be financed, since in general, the requirements and processing times are similar to loans required for projects of any kind,in the which mechanisms are not developed to value intangibles associated with innovation and its quality.

Thus, the government, must also create and maintain links between public entities, the University and the industry, prioritizing projects of collaboration through incentives for professors who generate developments in science, technology and innovation, in addition to guaranteeing an education that stimulates innovation and entrepreneurship, since the idea is to develop human talent that is involved in these projects. All the above, placing the enterprises at the center of the Colombian innovation system, since they convert knowledge into new goods, which is why Colombia must continue to implement tax incentives in order to encourage investment in innovation by companies and thus improve their competitiveness.

On the other hand, given the importance of the economy in which the firm operates for the innovative project success, the government must develop a public policy in a macro environment in order to promote the exchange of information of the company for investors, thus allowing to generate trust between the actors, and in order to guarantee fair conditions of competition in the market, as well as high appropriability of innovations and to allow companies to get loans from the bank more easily.

Finally, according to the results of the review of the literature about the Colombian capital market problems, it is necessary to review access to capital for companies and develop policies that aim to correct information asymmetries between actors, and to generate incentives to use this funding source more frequently.

5. RECOMMENDATIONS

- ✓ It is recommended to include some variables of interest in the databases related to the age of the companies to analyze the change in the sources of financing for innovation and, thus, the stage of the life cycle in which the company is, since it could allow to analyze the difficulties that younger companies have to meet the requirements to accessing external financing sources.

- ✓ This analysis is based on data of a micro nature, which is why it is recommended to carry out studies that involve macroeconomic aspects, (the economic and legal environment) that allow evidence of the impact of the market in which companies operate and its effects on decisions related to innovation.

- ✓ The significant negative relationships between the investment percentage of *Own Resources* and *Private Banking* and between *Own resources* and *Private Equity Funds* raises a research question not examined here: the possible

Pecking Order Theory between the use of these three types of financing sources, in which the literature review is still contradictory, especially for developing countries.

- ✓ To promote and create an adequate context for innovation, proper public policies are necessary to increase public resources and their allocation. Therefore, the Colombian State should take a more proactive stance in improving the opportunities/sources to finance innovation by considering incentives that facilitate the development of the capital market in Colombia, by introducing policies that promote simples procedures to access external sources of financing, and by improving fiscal incentives so that firms increase the internal resources used to finance innovation.

- ✓ It is important that when developing policies focused on the use of public resources and their allocation in innovation activities, Colombian State does not take the example of developed countries, since how companies finance their innovations depends not only on themselves but also on the market that characterizes the country where the firm operates.

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APPENDIX

A1. EDIT Questionnaire

CHAPTER I - INNOVATION AND ITS IMPACT ON THE COMPANY IN THE PERIOD 2017 - 2018

An innovation is defined in this survey as a new or significantly improved product (good or service) introduced to the market, or a new or significantly improved process introduced in the company, or a new organizational method introduced in the company, or a technique of new marketing introduced into the company.

a. *An innovation is always new to the company. It does not have to be new to the market in which the company operates.*
b. *Changes of an aesthetic nature, and simple organizational or management changes do not count asinnovation.*
c. *Both the goods and the services that the company introduces to the market are considered as products. Services, unlike goods, are usually intangible or difficult to store products and their production and marketing processes can occur simultaneously.*
d. *The supply of a service may have as a complement, or require as support, the supplyof a good; and vice versa.*

Who should answer this chapter?
People with first-hand knowledge of the scientific, technological and innovation activities carried out by the company

I.1 Indicate whether during the period 2017 - 2018 your company introduced any of the following innovations. If yes, specify the number.

Please note: A **new good or service is** a product whose fundamental characteristics (technical specifications, components and materials, embedded software or intended uses) are new in relation to those corresponding to those corresponding to previous products produced by the company.

			Total Innovations in 2017 - 2018
1. New goods or services only for your company *(They* already *existed in the domestic and/or international market).*	I1R1C1N	YES ◯ NO ◯	I1R1C2N
2. New goods or services in the domestic market (They already existed in the international market).	I1R2C1N	YES ◯ NO ◯	I1R2C2N
	I1R3C1N	YES ◯ NO ◯	I1R3C2N
3. New goods or services on the international market.			I1R4C2N
Total innovations in new goods or services			

Please note: A significantly **improved good or service is** a product whose performance has been greatly improved or refined. It can be caused by the use of better performance components or materials, or by changes to one of the technical subsystems that makeup a complex product.

			Total Innovations in 2017 - 2018
1. Significantly improved goods or services for your company *(They already existed in the domestic and/or international market).*	I1R1C1M	YES ◯ NO ◯	I1R1C2M
2. Significantly improved goods or services in the domestic market *(They already existed on the international market).*	I1R2C1M	YES ◯ NO ◯	I1R2C2M
3. Significantly improved goods or services in the international market	I1R3C1M	YES ◯ NO ◯	I1R3C2M
Total innovations in significantly improved goods or services			I1R4C2M

Other types ofInnovations

1. Introduced **new** or **significantly improved** processes, production methods, distribution, delivery or logistics systems in your company.	I1R4C1	YES ◯ NO ◯	I1R4C2
	I1R5C1	YES ◯ NO ◯	I1R5C2
2. Introduced new organizational methods implemented in the inner workings of the company, in the knowledge management system, in the organization of the workplace, or in the management of the external relations of the company.			I1R6C2
3. Introduced new marketing techniques in his company (channels for promotion and sale, or significant modifications to the packaging or design of the product), implemented in the company with the aim of expanding or maintaining its market. *(Changes affecting product functionalities are excluded as that would correspond to a significantly good or service improved).*	I1R6C1	YES ◯ NO ◯	

If you answered NO to all options (1 ,2, 3, 4, 5, 6, 7, 8, and 9) of the previous numeral (I.1), continue in numeral (I.3))

I.2 Point out the degree of importance of the impact, which had on the following aspects of your company during the period 2017 - 2018, the introduction of new or significantly improved goods or services, and/or the implementation of new or significantly improved processes, new organizational methods, or new marketing techniques.

		Degree of importance		
		High	Medium	Null
Product				
1 Improving the quality of goodsor services	I2R1C1	○	○	○
2 Expansion in the range of goods or services	I2R2C1	○	○	○
Market				
3 Have maintained his share of his company'sgeographic market	I2R3C1	○	○	○
4 Have entered a new geographic market	I2R4C1	○	○	○
Process				
5 Increasing productivity	I2R5C1	○	○	○
6 Reducing labor costs	I2R6C1	○	○	○
7 Reduction in the use of raw materials or inputs	I2R7C1	○	○	○
8 Reduction in consumption of electricity or other energy	I2R8C1	○	○	○
9 Reduction in water consumption	I2R9C1	○	○	○
10 Reduction in costs associated with communications	I2R10C1			
11 Reduction in transportation costs	I2R11C1			
12 Reduction in maintenance and repair costs	I2R12C1			
Other impacts				
13 Improved compliance with regulations, standards, and technical regulations. Includes compliance with standards for reducing crushes or toxic emissions and improving industrialsafety conditions.	I2R13C1	○	○	○
14 Use of waste in the company's processes	I2R14C1	○	○	○
15 Decrease in tax pay	I2R15C1			

EMPLOYER(A)

How should monetary figures be reported?

Report all financial and monetary figures in THOUSANDS of pesos
Example:
If the figure to be reported is **$179,125,825**
So the figure to be entered on the form will be **$179,126**

I.3 Enter the value for your company's domestic operating revenue or sales and exports in 2017 and 2018. (In thousands of current weights)

	Total national revenue or sales	Total exports
2017	I3R1C1	I3R1C2
2018	I3R2C1	I3R2C2

I.4 Distribute in percentages the value of domestic operating income or sales and exports for the year 2018, reported in numeral I.3, according to the following classification. Verify that the sum of each column is 100%.

	National (%)	Exports (%)
1 Goods or services significantly new or improved for the company *(They already existed in the domestic and/or international market)*	I4R1C1	I4R1C2
2 Goods or services significantly new or improved in the domestic market *(They already the international*	I4R2C1	I4R2C2
3 Goods or services new or significantly improved in the international	I4R3C1	I4R3C2
4 Goods or services that remained unchanged or whose changes were not (non-innovative	I4R4C1	I4R4C2
Total	100% I4R5C1	100% I4R5C2

I.5 At the end of 2018, did your company have any projects underway, i.e. not completed, for the introduction of new or significantly improved goods or services, and/or the implementation of new or significantly improved processes, new organizational methods, or new marketing techniques?

I5R1C1 **YES** **NO**

I.6 During the period 2017 - 2018, did your company abandon any projects for the introduction of new or significantly improved goods or services, or for the implementation of new or significantly improved processes, new organizational methods, or new marketing techniques, whether you had started it during this period or in previous periods?

I.7 Of the innovations introduced by your company, or projects underway or abandoned for innovations during the period 2017-2018 were activities carried out related to biotechnology?

Biotechnology is the application of science and technology to living organisms, as well as parts, products and models thereof, to alter living materials or not, in order to produce knowledge, goods or services.

II2R1C1 ◯ **YES** ◯ **NO**

I.8 During the period 2017 - 2018, did your company intend to carry out any projects for the introduction of new or significantly improved goods or services, and/or the implementation of new or significantly improved processes, new organizational methods, or new marketing techniques?

I7R1C1 ◯ **YES** ◯ **NO**

I.9 In the period 2017 - 2018, did your company obtain any contracts to provide goods or services to...

1 National public sector entities?	◯ **YES**	◯ **NO**	I8R1C1
2 Foreign public sector entities?	◯ **YES**	◯ **NO**	I8R2C1

I.10 Within the contracts that your company entered into with public sector entities (question I.9), was the supply of any of the new or significantly improved goods or services that your company introduced during the 2017-2018 period (question I.1 options 1 to 6)

1 With national public sector entities?	**YES**	◯ **NO**	I9R1C1
2 With foreign public sector entities?	**YES**	◯ **NO**	I9R2C1

I.11 Point out the degree of importance that the following obstacles had, for the introduction of new or significantly improved goods or services, and/or the implementation of new or significantly improved processes, new organizational methods, or new marketing techniques in your company, during the period 2017-2018:

		Degree of importance		
		High	**Medium**	**Null**
Obstacles associated with internal information and capabilities				
1 Scarcity of own resources	I10R1C1	◯	◯	◯
2 Lack of skilled staff	I10R2C1	◯	◯	◯
3 Difficulty complying with regulations and technical regulations	I10R3C1	◯	◯	◯
4 Little market information	I10R4C1	◯	◯	◯
5 Little information on available technology	I10R5C1	◯	◯	◯
6 Little information on public instruments of support	I10R6C1	◯	◯	◯
Obstacles associated with risks.				
7 Uncertainty in the face of demand for innovative goods or services	I10R7C1	◯	◯	◯
8 Uncertainty about success in the technical implementation of the project 9 Low profitability of innovation	I10R8C1	◯	◯	◯
	I10R9C1	◯	◯	◯
Obstacles associated with the environment.				
10 Difficulties accessing financing outside the company.	I10R10C1	◯	◯	◯
11 Few possibilities for cooperation with other companies or institutions	I10R11C1	◯	◯	◯
12 Ease of imitation by third-party agents	I10R12C1	◯	◯	◯
13 Insufficient capacity of the intellectual property system to protect innovation.	I10R13C1	◯	◯	◯
14 Low offer of inspection, testing, calibration, certification and verification services	I10R14C1	◯	◯	◯

CHAPTER II - INVESTMENT IN SCIENTIFIC, TECHNOLOGICAL AND INNOVATION ACTIVITIES IN 2017 AND 2018

Scientific, Technological *and Innovation Activities (ACTI) are all those* activities that *the* company *carries out to produce, promote, disseminate and / or* apply *scientific and technical knowledge; as well as for the development* ***or*** introduction ***of new*** or ***significantly*** improved goods ***or*** *services, new or significantly improved processes, new organizational methods,* or *new marketing techniques* .

Who should answer this chapter?

People in the financial area who know the investments and expenses of the company in scientific, technological and innovation activities

EMPLOYER

How should monetary figures be reported? Report all financial and monetary figures in THOUSANDS of pesos

Example:
If the figure to be reported is
$179,125,825
So the figure to be entered on the form will be **$179,126**

II.1 Indicate the value invested by your company in 2017 and 2018, in each of the following scientific, technological and innovati on activities, for the introduction of new or significantly improved goods or services, and/or the implementation of new or significantly improved processes, new organizational methods, or new marketing techniques.

		Amount invested 2017 (Thousands of current pesos)	Amount invested 2018 (Thousands of current pesos)
1	**Internal R&D Activities** Systematic creation work carried out within the company in order to increase the volume of knowledge and its use to devise and validate new or significantly improved services, goods or processes. (Corresponds only to the investment amounts associated with the research and development stage, prior to the production of new or significantly new services, goods or processes improved).	II1R1C1	II1R1C2
2	**Acquisition of R&D (external)** Acquisition or financing of the same activities as those indicated above (R&D) but carried out by other public or private organizations (includes research bodies).	II1R2C1	II1R2C2
3	**Acquisition of machinery and equipment** Machinery and equipment, specifically purchased for the production or introduction of new or significantly improved services, goods or processes. (Do not include R&D machinery and equipment registered in item 1, nor the machinery purchased simply for the replacement or expansion of installed capacity, i.e. those dedicated to traditional production).	II1R3C1	II1R3C2
4	**Information and telecommunications technologies** Acquisition, generation, outsourcing or leasing of hardware, software and/or services for the handling or processing of information, specifically intended for the production or introduction of new or significantly improved services, goods or processes. (Do not include information and telecommunications technologies for R&D recorded in item 1, or those purchased simply for the replacement or expansion of installed capacity, i.e. those dedicated to traditional production).	II1R4C1	II1R4C2
5	**Marketing** It is the investment in a new marketing method that involves significant changes in the design or packaging of a product - whether new or not - as well as its positioning, promotion or pricing. It includes new market research techniques and launch advertising.	II1R5C1	II1R5C2

6	**Transfer of technology and/or acquisition of other external knowledge** Acquisition or use under license, patents or other intellectual property registrations, non-patented inventions and technical or other knowledge; other companies or organizations to use in your company's innovations. It includes access to summaries bases and bibliographic references of scientific or engineering literature, as well as *know-how transfer modalities,* defined as those related to und written knowledge and not protected by patents. (Do not include those reported in internal and external R&D acquisition).	II1R6C1	II1R6C2
7	**Technical assistance and consulting** Advice for the use of applied technological knowledge, through the exercise of an art or technique, specifically contracted for the production or introduction of new or significantly improved services, goods or processes. It includes processes of surveying, monitoring or technological monitoring and competitive intelligence, among others. (Do not include those reported in internal and external R&D acquisition).	II1R7C1	II1R7C2
8	**Engineering and industrial design** Changes in production methods or patterns and quality control, and elaboration of plans and designs aimed at defining technical procedures, necessary for the production or introductionof new or significantly improved services, goods or processes in the company. (Do not include what is reported in internal and external R&D acquisition).	II1R8C1	II1R8C2
9	**Training and qualification** Training of its staff, whether internal or external, specifically aimed at the introduction of new or significantly improved products, and/or the implementation of new or significantly improved processes, new organizational methods, or new marketing techniques. (Do not include what is reported in internal and external R&D acquisition).	II1R9C1	II1R9C2
TOTAL AMOUNT INVESTED		II1R10C1	II1R10C2

II.2 Of the total value invested in ACTI (question II.1), indicate the amount corresponding to Biotechnology-related activities carried out by your company in 2017 and 2018.

Investment in biotechnology-related activities must be less than or equal to the total value reported in numeral II.1

Amount invested 2017 (Thousands of Current pesos)	Amount invested 2018 (Thousands of current pesos)
II3R1C1	II3R1C2

The company can make use of its own resources, i.e. allocate funds from the exercise *of its activity to finance investments* in *scientific, technological and innovation activities. However, you may also finance or co-finance such activities through public resources, whether reimbursable or not, or through the use of private resources from third parties such as credit, capital investments, private banking, private agencies or organizations (domestic and international), among others.*

Remember: Scientific, Technological and Innovation Activities (ACTIs) are all those that the company performs to produce, promote, disseminate and apply scientific and technical knowledge; as well as for the development or introduction of innovations.

Who should answer this chapter?
People in the financial area who know the investments and expenses of the company in scientific, technological and innovation activities

EMPLOYER

How should monetary figures be reported?
Report all financial and monetary figures in THOUSANDS of

Example:
If the figure to be reported is **$179,125,825**
So the figure to be entered on the form will be **$179,126**

III.1 Distribute the total invested in scientific, technological and innovation activities (total Chapter II investment), according to the original source of the resources used to finance such investments in 2017 and 2018. It should be distinguished between the use of company own resources, resources of other companies in the group, public resources, private banking resources, resources of other companies outside the group, private equity funds and resources cooperation or donations.

Thousands of current weights

	2017	2018
1 Company's own resources Funds belonging to the company that come from its operational and non-operational income, or capitalization of shares, intended to finance investments in scientific, technological and innovation activities, and/or those intended to serve as a counterparty, in the event that the company is a beneficiary of national and international organizations, whether public, private or mixed.	III1R1C	III1R1C
2 Resources from other companies in the group Funds belonging to other companies in the same group (with which there is a close legal or financial relationship), which are granted to the company as a loan or donation to finance investments in scientific, technological and innovation activities.	III1R2C	III1R2C
3 Public resources for the realization of ACTI Funds obtained through some of the public funding lines for the realization of scientific, technological and innovation activities (listed in numeral III.2). These can be refundable (credit lines) or non-refundable resources that were offset (co-financing lines).	III1R3C	III1R3C

	2017 National	2017 Foreign	2018 National	2018 Foreign
4 Private banking resources Funds granted by privately owned financial institutions that perform recruitment and financing functions.	III1R4C1	III1R4C2	III1R4C3	III1R4C4
5 Resources from other companies Funds belonging to other companies **that are not part of the** same group that are granted to the company as a loan or donation to finance investments in scientific, technological and innovation activities	III1R5C1	III1R5C2	III1R5C3	III1R5C4
6 Private equity funds Funds from investor contributions that are linked to the company through private equity funds, venture capital funds, securities exchange operations, or specific investments such as those of angels investors. The share capitalization described in numeral III.1 is excluded. option 1.	III1R6C1	III1R6C2	III1R6C3	III1R6C4
7 Cooperation resources or donations Non-reimbursable funds granted by national or foreign governmental or non-governmental organizations. Funds can be in cash, goods, or services. Donations made by private national organizations or public, private, or mixed international organizations should also be included. Include public resources that do not come from funding lines for scientific, technological and innovation activities that must be recorded in numeral III.1 option 3.	III1R7C1	III1R7C2	III1R7C3	III1R7C4
TOTAL (must be EQUAL to total invested)	III1R8C1		III1R8C2	

If you did use public resources in 2017 and 2018, that is, if your response was 0 (zero) in the two boxes in option 3 of the previous numeral (III.1), continue in the numeral (III.3)

III.2 Distribute the amount of public resources used in 2017 and 2018 to finance investments in scientific, technological and innovation activities (option 3 of numeral III.1), according to the funding line by which the resources were obtained.

Co-financing lines	Thousands of current weights	
Non-refundable resources granted to finance a percentage (less than 100%) of the total value of a research, technological development and innovation project. A cash or species offset by the company is required in this type of financing.	**2017**	**2018**
1 **BANCOLDEX - INNpulsa - MinComercio.** Extraordinary Growth, MSM and Regional Growth	III2R1C1	III2R1C2
2 **SENA.** Promoting innovation and technological development in companies and technology corridors	III2R2C1	III2R2C2
3 **COLCIENCIAS.** Patents (Call 793), Biotechnology (764: Portfolio 100, Institutional Links - Newton Fund. Annual Call for International Center for Genetic Egineering and Biotechnology - ICGEB), Innovation Partnerships, ICT, Business Innovation Systems.	III2R3C1	III2R3C2
4 **COLCIENCIAS.** Applied Research Projects - Technological Development - R&D&I Programs in Thermal Efficiency - Proof-of-Concept Projects, Postdoctoral Stays. National call young researchers and innovators in SENA alliance 2016-2017	III2R4C1	III2R4C2
5 Colciencias. Locomotive of innovation for companies **(technological development and innovation).**	III2R5C1	III2R5C2

Credit lines	Thousands of current weights	
Reimbursable resources to finance up to 100% of the total value of a research, technological development and innovation project.	**2017**	**2018**
6 BANCOLDEX - INNpulsa. Promote and energize the innovation of large companies and Smes.	III2R6C1	III2R6C2
7 BANCOLDEX. Business modernization.	III2R7C1	III2R7C2

Other lines	Thousands of current weights	
	2017	**2018**
8 Departmental or municipal science and technolgy funds	III2R8C1	III2R8C2
9 General royalty system science, technology and innovation fund	III2R9C1	III2R9C2
Total (must be equal to option 3 of numeral III.1)	III2R10C1	III2R10C2

III.3 Did your company intend to apply for public resources to finance investments in scientific, technological and innovation acti vities in your company, during 2017 - 2018?

III3R1C1 **YES** ◯ **NO** ◯

III.4 Point out the degree of importance of the following obstacles in accessing public resources to finance investments in scientific, technological and innovation activities in your company, during the period 2017 - 2018:

		Degree of importance		
		High	**Medium**	**Null**
1	Disrecognisement of existing public funding lines	III4R1C1		
2	Lack of information on requirements and procedures	III4R2C1		
3	Difficulty meeting the requirements or completing the paperwork	III4R3C1		
4	Excessive processing time	III4R4C1		
5	Unattractive financing and/or co-financing conditions	III4R5C1		
6	Delay in intermediation between commercial banking and public credit lines	III4R6C1		

III.5 Select one of the following options, in relation to tax benefits (deductions or exemptions) for investments in scientific and technological development during 2017 - 2018:

1	Earned tax benefits	III5R1C1
2	Applied for tax benefits, but did not obtain them	◯
3	Intended to apply for tax benefits, but he did not	◯
4	Didn't want to apply for tax benefits.	◯

III.6 Indicate which of the following factors were an obstacle to applying for or obtaining tax benefits for investments in scienti fic and technological development, during the period 2017 - 2018:

		Investment rental deduction for science, technology and Innovation	Income and/or VAT exemptions from investments for science, technology and innovation projects
1	Lack of Information on Benefits and Requirements	III6R1C1	III6R1C2
2	Difficulties with the online application tool through the Comprehensive Project Management System (SIGP)	III6R2C1	III6R2C2
3	Difficulty diligence of the electronic form	III6R3C1	III6R3C2
4	Excessive and/or complex requirements and formalities	III6R4C1	III6R4C2
5	Excessive approval processing time	III6R5C1	III6R5C2
6	Little profit from tax benefit	III6R6C1	III6R6C2
7	The law partially excludes innovation activities and projects that develops the company	III6R7C1	III6R7C2
8	Found no obstacles	III6R8C1	III6R8C2

CHAPTER IV- AVERAGE BUSY STAFF IN RELATION TO STI ACTIVITIES DURING 2017 AND 2018

The *staff employed average* in *the year by* the *company corresponds* to the *one* who *exercises* its workforce *regardless* of the *type* of *contracting whether owning, permanent, temporary persons hired directly or* through *agencies, trainees or trainees* in practical stage or personnel for the provision of services, with the exception of external consulting agents hired for the realization of scientific, technological and innovation activities.

The *staff involved in scientific,* technological and *innovation* activities *correspond to the staff* who carry *out, either in permanent or partial dedication,* activities *within the company* aimed at *the production, promotion, dissemination and application* of *scientific and technical knowledge; and the development or introduction of new or significantly improved* goods or *services, new or significantly improved processes, new organizational methods, or new marketing techniques.*

Who should answer this chapter?
People in the human resources area and with access to information from the employees of the company.

IV.1 Indicate the average busy staff who worked at your company in 2017 and 2018. From this, specify the number that participated in the realization of scientific, technological and innovation activities in 2017 and 2018, according to the highest level of education achieved and with a degree obtained.

Highest level of education achieved	Average busy staff (full-time, permanent and temporary)		Average busy staff involved in the realization of scientific, technological and innovation activities	
	2017	2018	2017	2018
1 Doctorate	IV1R1C1	IV1R1C2	IV1R1C3	IV1R1C4
2 Master	IV1R2C1	IV1R2C2	IV1R2C3	IV1R2C4
3 Specialization	IV1R3C1	IV1R3C2	IV1R3C3	IV1R3C4
4 University (Professional)	IV1R4C1	IV1R4C2	IV1R4C3	IV1R4C4
5 Technologist	IV1R5C1	IV1R5C2	IV1R5C3	IV1R5C4
6 Professional technician	IV1R6C1	IV1R6C2	IV1R6C3	IV1R6C4
7 Secondary Education (Full)	IV1R7C1	IV1R7C2	IV1R7C3	IV1R7C4
8 Primary education	IV1R8C1	IV1R8C2	IV1R8C3	IV1R8C4
9 Comprehensive Vocational Training - SENA				

IV. 2 Indicate the average number of persons employed with competency certifications inherent in the main activity carried out by the company:

Certification refers to the culmination of a process of formal recognition of worker competencies that are dedicated to the main activity of the company, based on a time of training and practice of a specific job, as well as evaluated content. It involves the issuance by an authorized institution of an accreditation about the competence acquired by the worker. Certifications of labor competencies are issued with a predetermined validity by SENA or certifying bodies accredited by the Superintendency of Industry and Commerce, and they are NOT Formal Education qualifications as defined in question IV.1.

IV. 3 Distribute the average busy staff who participated in scientific, technological and innovation activities in your company in 2017 and 2018 (question IV.1), according to the department(s) where these innovation activities were developed and implemented:

Departament	2017	2018	Departament	2017	2018	Departament	2017	2018
1. Amazonas	IV2R1C1	IV2R1C2	12. Cesar	IV2R12C1	IV2R12C2	23. Norte de Santander	IV2R23C1	IV2R23C2
2. Antioquia	IV2R2C1	IV2R2C2	13. Chocó	IV2R13C1	IV2R13C2	24. Putumayo	IV2R24C1	IV2R24C2
3. Arauca	IV2R3C1	IV2R3C2	14. Córdoba	IV2R14C1	IV2R14C2	25. Quindío	IV2R25C1	IV2R25C2
4. Atlantico	IV2R4C1	IV2R4C2	15. Cundinamarca	IV2R15C1	IV2R15C2	26. Risaralda	IV2R26C1	IV2R26C2
5. Bogotá D.C.	IV2R5C1	IV2R5C2	16. Guainía	IV2R16C1	IV2R16C2	27. San Andres y Providencia	IV2R27C1	IV2R27C2
6. Bolivar	IV2R6C1	IV2R6C2	17. Guaviare	IV2R17C1	IV2R17C2	28. Santander	IV2R28C1	IV2R28C2
7. Boyacá	IV2R7C1	IV2R7C2	18. Huila	IV2R18C1	IV2R18C2	29. Sucre	IV2R29C1	IV2R29C2
8. Caldas	IV2R8C1	IV2R8C2	19. La Guajira	IV2R19C1	IV2R19C2	30. Tolima	IV2R30C1	IV2R30C2
9. Caquetá	IV2R9C1	IV2R9C2	20. Magdalena	IV2R20C1	IV2R20C2	31. Valle del Cauca	IV2R31C1	IV2R31C2
10. Casanare	IV2R10C1	IV2R10C2	21. Meta	IV2R21C1	IV2R21C2	32. Vaupés	IV2R32C1	IV2R32C2
11. Cauca	IV2R11C1	IV2R11C2	22. Nariño	IV2R22C1	IV2R22C2	33. Vichada	IV2R33C1	IV2R33C2
						Total *(Suma de los ítems 1 al 33)*	IV2R34C1	IV2R34C2

IV.4 Distribute the average busy staff who participated in scientific, technological and innovation activities in your company during 2018 (question IV.1), depending on your main functional area and gender:

1 General management	IV4R1C1	IV4R1C2	IV4R1C3
2 Administration	IV4R2C1	IV4R2C2	IV4R2C3
3 Marketing and sales	IV4R3C1	IV4R3C2	IV4R3C3
4 Production	IV4R4C1	IV4R4C2	IV4R4C3
5 Accounting and financial	IV4R5C1	IV4R5C2	IV4R5C3

6 Research and development *(This one is in turn disaggregated in the following four items. Do not include external consultants)*

6.1 Researchers: coordinators, project leaders and / or managers	IV4R7C1	IV4R7C2	IV4R7C3
6.2 Research and development coaches or assistants			
6.3 Technical staff in research and development	IV4R9C1	IV4R9C2	IV4R9C3
6.4 Assistants and / or administrative support in Research and Development	IV4R10C1	IV4R10C2	IV4R10C3
Total personal involucrado en actividades científicas, tecnológicas y de innovación ***(Suma de las opciones 1 a 6)***	IV4R11C1	IV4R11C2	IV4R11C3

IV. 5 Distribute the average busy staff with higher educational level who participated in scientific, technological and innovation activities in your company during 2018 (question IV.1 options 1 - 6), depending on the area of training of the highest level of education obtained and sex:
(Higher education levels are professional technician, technologist, university, specialization, master's and doctoral)

Background	Men	Women	Total
1 Exact sciences associated with chemistry, physics, mathematics and statistics *Include: physics, chemistry, mathematics, statistics and related*	IV6R1C1	IV6R1C2	IV6R1C3
2 Natural sciences *Include: biology, microbiology, biotechnology, geology and related*	IV6R2C1	IV6R2C2	IV6R2C3
3 Health sciences *Include: bacteriology, nursing, surgical instrumentation, medicine, nutrition and dietetics, dentistry, optometry, public health, therapy and related.*	IV6R3C1	IV6R3C2	IV6R3C3
4 Engineering, architecture, urban planning and related *Include: architecture, urban planning, engineering (administrative, agricultural, forestry, agro-industrial, food, agronomic, livestock, environmental, sanitary, biomedical, civil, mine, metallurgical, systems, telematics, electrical, electronics, telecommunications, industrial, mechanical, chemical* and *others) and related.*	IV6R4C1	IV6R4C2	IV6R4C3
5 Agronomy, veterinary and related *Include: agronomy, veterinary, zootechnics and related.*			
6 Social sciences *Include: economy, administration,* public *accounting, political science, international relations, social communication, journalism, law, military or* police *training, sociology, social work, other social sciences* and *related .*			
7 Human sciences and fine arts *Include: languages, anthropology, liberal arts, plastic* arts, visual *arts, representative arts, biblotecology, sports, design, physical education, philosophy, theology, geography, history, modern languages, literature, lymphatics, music, psychology, advertising, and related.*			
Total average employed personnel with a higher education level involved in scientific, technological and innovation activities	IV6R8C1	IV6R8C2	IV6R8C3

IV.6 Did your company hire external consulting agents to carry out scientific, technological and innovation activities during 2018? If yes, indicate the number of consultants who provided services both within and outside the company:

IV5R1C1 **YES** ◯ **NO** ◯

Number of consulting agents providing services within the company (has a job at the company's facilities)
Number of consulting agents providing services outside the company (no job on the company's facilities)

IV. 7 Indicate the number of busy persons who received training and training specifically related to scientific, technological and innovation activities (corresponding to the value recorded in Chapter II - Question 1 - Item 9), depending on the type of training provided, financed or co-financed by the company in 2017 and 2018:

	Trained people	
	2017	2018
1 Doctorate: training of its staff, leading to a doctoral degree (Ph.D), aimed at scientific, technological and innovation activities carried out by the company.	IV7R1C1	IV7R1C2
2 Master's degree: training of its staff, leading to a master's degree (MSc, MA, MBA), aimed at scientific, technological and innovation activities carried out by the company.	IV7R2C1	IV7R2C2
3 Specialization: training of its staff, leading to a specialist degree, aimed at scientific, technological and innovation activities carried out by the company.	IV7R3C1	IV7R3C2
4 Training equal or greater than 40 hours: training of its staff, whether internal or external to the company, with a duration equal to or greater than 40 hours; intended for scientific, technological and innovation activities carried out by the company.	IV7R4C1	IV7R4C2
Total staff trained and / or financed	IV7R5C1	IV7R5C2

CHAPTER V – RELATIONSHIPS WITH ENTITIES OF THE NATIONAL SYSTEM OF SCIENCE, TECHNOLOGY AND INNOVATION AND COOPERATION FOR INNOVATION IN THE PERIOD 2017 - 2018

The National System of Science, Technology and Innovation (SNCTI) is an open system of which are part *of policies, strategies, programmes, methodologies and mechanisms for the management, promotion, financing, protection and dissemination of scientific research and technological innovation, as well as public, private or mixed organizations that carry out or promote the development of scientific, technological and innovation activities (Law 1286 of 2009).*

The realization of scientific, technological and innovation activities in the company depends in part on the diversity and structure of the relationships it establishes with other organizations (public, private *or* mixed) and *the degree of use* of *sources of information to provide* new ideas *to develop or implement innovations. Such relationships may exist both with internal sources* to the *company, i.e. groups, departments or individuals within the same company or other companies in the same group; and with sources outside the company, i.e. organizations or companies* that do not belong to the business group, or means of information of free *access.*

Who should answer this chapter?
Persons in charge of the management of innovation projects with knowledge of the agreements (contractual or non-contractual) made by the company internally and with other companies or actors

V.1 Point out whether or not the following sources of information and knowledge were important as a source of ideas for developing or implementing new or significantly improved goods or services, new or significantly improved processes, new organizational methods, or new marketing techniques, during the period 2017 - 2018 in your company. If yes for external sources, indicate the source whether it is domestic or foreign.

Internal sources to the company

1 Internal R&D Department	V1R1C1	YES ◯	NO
2 Production or operations department	V1R2C1	YES	NO
3 Sales and Marketing Department	V1R3C1	YES	NO
4 Another department of the company	V1R4C1	YES	NO
5Specific interdisciplinary groups to innovate	V1R5C1	YES	NO
6Board members of the company	V1R6C1	YES ◯	NO
7 Other related company (if part of a conglomerate)	V1R7C1	YES ◯	NO
8 Foreign parent company	V1R8C1	YES	NO

Sources outside the company

				Provenance: National	Provenance: Foreign		
9 R&D department of another company in the sector	V1R9C1	YES	NO			V1R9C2	V1R9C3
10 Other competing companies in the sector (except R&D department)	V1R10C1	YES ◯	NO ◯	◯		V1R10C2	V1R10C3
11 Customers	V1R11C1	YES	NO			V1R11C2	V1R11C3
12 Suppliers	V1R12C1	YES	NO			V1R12C2	V1R12C3
13 Companies from another sector	V1R13C1	YES	NO			V1R13C2	V1R13C3
14 Associations	V1R14C1	YES	NO			V1R14C2	V1R14C3
15 Chambers of Commerce	V1R15C1	YES	NO		◯	V1R15C2	V1R15C3
16 Technology Development Centres (CDT)	V1R16C1	YES	NO			V1R16C2	V1R16C3
17 Autonomous Research Centres	V1R17C1	YES	NO			V1R17C2	V1R17C3
18 Technology Base Enterprises Incubators (IEBT)	V1R18C1	YES	NO			V1R18C2	V1R18C3
19 Technology parks	V1R19C1	YES	NO			V1R19C2	V1R19C3
20 Regional Productivity Centres	V1R20C1	YES	NO			V1R20C2	V1R20C3
21 Universities	V1R21C1	YES	NO			V1R21C2	V1R21C3
22 Training Centres and/or research technoparks	V1R22C1	YES	NO			V1R22C2	V1R22C3
23 Consultants, experts	V1R23C1	YES	NO			V1R23C2	V1R23C3
24 Fairs and exhibitions	V1R24C1	YES	NO			V1R24C2	V1F24C3
25 Seminars and conferencies	V1R25C1	YES	NO			V1R25C2	V1R25C3
26 Books, magazines or catalogues	V1R26C1	YES	NO	◯		V1R26C2	V1R26C3
27 Industrial Property Information Systems (Patent Bank)	V1R27C1	YES ◯	NO	◯			
28 Copyright Information System	V1R28C1	YES	NO	◯			
29 Internet	V1R29C1	YES	NO			V1R29C2	V1R29C3
30 Scientific and technological databases	V1R30C1	YES	NO	◯	◯	V1R30C2	V1R30C3
31 Technical standards and regulations	V1R31C1	YES	NO	◯	◯	V1R31C2	V1R31C3
32 Public institutions (ministries, entities decentralized secretariats)	V1R32C1	YES	NO			V1R32C2	V1R32C3

V.2 Indicate whether during the period 2017 - 2018 your company had any relationship with the following CNSC entities, such as support for scientific, technological and innovation activities, in the search for new or significantly improved goods or services, new or significantly improved processes, new organizational methods, or new marketing techniques.

Relationships that support the realization of scientific, technological and innovation activities include the exchange of information on policies, strategies, programmes or methodologies, in support of the realization of STI activities; the transfer of knowledge, advice, accompaniment or funding for the planning or implementation of STI activities; outsourcing of services or work necessary for the realization of ACTI; and joint participation in concertation, outreach or debate processes on the state of science, technology and innovation.

1 Administrative Department of Science, Technology andInnovation(COLCIENCIAS)
2 SENA
3 ICONTEC
4 Superintendency of Industry and Commerce (SIC)
5 National Copyright Directorate
6 Ministries
7 Universities
8 Technology Development Centres(CDT)
9 Autonomous Research Centers
10 Technology-based Enterprises Incubators(IEBT) 11 Technology Parks
12 Regional Productivity Centres
13 Departmental Council of Science and Technology(CODECyT) 14 Regional Competitiveness Commissions
15 Sectoral Associations and Chambers of Commerce
16 Consultants in Innovation and Technological Development
17 PROEXPORT - PROCOLOMBIA
18 BANCOLDEX
19 Entidades de formación técnica y tecnológica (distintas al SENA)

V.3 In the period 2017 - 2018, did your company cooperate with any of the following types of partners for the realization of scientific, technological and innovation activities?. If yes, point out your location, whether domestic or foreign, and the objective of cooperation.

Cooperation to carry out scientific, technological and innovation activities, means active participation with other companies or non-commercial entities in joint R & D projects or other types of activities such as those described in Chapter II of this survey. It does not necessarily imply that the two parties derive economic benefits from the cooperation. The simple hiring of services or jobs from another organization without active cooperation is excluded.

	Types of partners			Partner location		Objective of cooperation								
				National	Foreign	Research and Development (R&D)	Acquisition of machinery and equipment	Information and telecommunication technologies	Marketing	Transfer of technology and/or acquisition of other external knowledge	Technical assistance and consulting	Engineering and industrial design	Training and training
1	Other companies in the same group (conglomerate)	YES	NO	V3R1C1	V3R1C2	V3R1C3	V3R1C4	V3R1C5	V3R1C6	V3R1C7	V3R1C8	V3R1C9	V3R1C10	V3R1C11
2	Suppliers	YES	NO	V3R2C1	V3R2C2	V3R2C3	V3R2C4	V3R2C5	V3R2C6	V3R2C7	V3R2C8	V3R2C9	V3R2C10	V3R2C11
3	Customers	YES	NO	V3R3C1	V3R3C2	V3R3C3	V3R3C4	V3R3C5	V3R3C6	V3R3C7	V3R3C8	V3R3C9	V3R3C10	V3R3C11
4	Competitor	YES	NO	V3R4C1	V3R4C2	V3R4C3	V3R4C4	V3R4C5	V3R4C6	V3R4C7	V3R4C8	V3R4C9	V3R4C10	V3R4C11
5	Consultant agents, experts or researchers	YES	NO	V3R5C1	V3R5C2	V3R5C3	V3R5C4	V3R5C5	V3R5C6	V3R5C7	V3R5C8	V3R5C9	V3R5C10	V3R5C11
6	Universities	YES	NO	V3R6C1	V3R6C2	V3R6C3	V3R6C4	V3R6C5	V3R6C6	V3R6C7	V3R6C8	V3R6C9	V3R6C10	V3R6C11
7	Technological Development Centers	YES	NO	V3R7C1	V3R7C2	V3R7C3	V3R7C4	V3R7C5	V3R7C6	V3R7C7	V3R7C8	V3R7C9	V3R7C10	V3R7C11
8	Autonomous research centers	YES	NO	V3R8C1	V3R8C2	V3R8C3	V3R8C4	V3R8C5	V3R8C6	V3R8C7	V3R8C8	V3R8C9	V3R8C10	V3R8C11
9	Technology parks	YES	NO	V3R9C1	V3R9C2	V3R9C3	V3R9C4	V3R9C5	V3R9C6	V3R9C7	V3R9C8	V3R9C9	V3R9C10	V3R9C11
10	Regional productivity centers	YES	NO	V3R10C1	V3R10C2	V3R10C3	V3R10C4	V3R10C5	V3R10C6	V3R10C7	V3R10C8	V3R10C9	V3R10C10	V3R10C11
11	Non-governmental organizations	YES	NO	V3R11C1	V3R11C2	V3R11C3	V3R11C4	V3R11C5	V3R11C6	V3R11C7	V3R11C8	V3R11C9	V3R11C10	V3R11C11
12	Government	YES	NO	V3R12C1	V3R12C2	V3R12C3	V3R12C4	V3R12C5	V3R12C6	V3R12C7	V3R12C8	V3R12C9	V3R12C10	V3R12C11

CHAPTER VI - INTELLECTUAL PROPERTY, QUALITY CERTIFICATIONS, TECHNICAL STANDARDS AND TECHNICAL REGULATIONS IN THE PERIOD 2017 - 2018

Who should answer this chapter?
People familiar with intellectual property concepts, patents, copyrights and quality management systems implemented in the company.

VI.1 For each of the following methods of protection, indicate whether your company owns intellectual property rights in effect as of December 2018, and specify the corresponding number of registrations.

Intellectual property protection records				**Total registrations in force as of December 2018**
Patents				
1.1 Patents for invention	VI1R1C1	**YES**	**NO**	VI1R1C2
Title that protects all new procedures, manufacturing method, machine, apparatus, product or a new solution, meeting the criteria of novelty, inventive height and industrial application. Applications are filed with national industrial property offices. In Colombia, the competent entity is the Superintendency of Industry and Commerce.				
1.2 Utility model patents	VI1R2C1	**YES**	**NO**	VI1R2C2
Title that protects any new form, configuration or arrangement of elements, any artifact, tool, instrument or other object or any part thereof, that allows a better or different operation, use or manufacture of the object that incorporates it or that provides it with any usefulness, advantage or technical effect that it did not previously have, with novelty and industrial application. Applications are filed with national patent offices. In Colombia, the competent entity is the Superintendency of Industry and Commerce.				
Copyright				
2.1 Copyright of literary, artistic, musical, audiovisual, architectural or phonogram works	VI1R3C1	**YES**	**NO**	VI1R3C2
Title given to creators of literary and artistic works. These include works written as novels, poems, plays; musical, artistic works such as paintings, sculptures, films and choreographies; architectural works such as maps and technical drawings; Phonograms. In Colombia, these rights are born with the creation of works; however, for reasons of legal certainty, for evidentiary purposes works may be registered with national copyright offices. In Colombia, the competent entity is the National Copyright Directorate, Special Administrative Unit of the Ministry of interior and justice. Softwar registrations excludede.				
2.2 Copyright of software records	VI1R4C1	**YES**	**NO**	VI1R4C2
Titles that protect, under copyright mode, applications and computer systems, which may be part of a computer or other type of device. Like other copyright titles, applications for registration are filed with national copyright offices. In Colombia, the competent entity is the National CopyrightDirectorate.				
Industrial design records	VI1R5C1	**YES**	**NO**	VI1R5C2
Title that protects all external or aesthetic forms of functional or decorative elements that serve as a pattern for production in industry, manufacturing or craftsmanship. Applications are filed with national industrial property offices. In Colombia, the competent entity is the Superintendency of Industry and Trade.				
Trademark registrations and other distinctive signs	VI1R6C1	**YES**	**NO**	VI1R6C2
Title that protects trademarks, trade slogans and appellations of origin. Applications are filed in national industrial property offices. In Colombia, the competent entity is the Superintendency of Industry and Commerce.				
Plant variety breeder certificates	VI1R7C1	**YES**	**NO**	VI1R7C2
Titles that protect the improvement of plant varieties used in agriculture, which may include higher yield characteristics and better resistance to pests and diseases. Applications are filed with national plant variety offices. In Colombia, the competent entity is the Colombian Agricultural Institute.				
Total intellectual property registrations in force as of December 2018				VI1R8C2

VI.2 For each of the following protection methods, indicate whether your company obtained intellectual property rights during the period 2017-2018, and specify the number of registrations.

Intellectual Property Protection Records (See definitions in VI.1)				**Total records obtained 2017 - 2018**
Patents				
1.1 Patents for invention	VI2R1C1	**YES**	**NO**	VI2R1C2
1.2 Utility model patents	VI2R2C1	**YES**	**NO**	VI2R2C2
Copyright				
2.1 Copyright of literary, artistic, musical works, audiovisual, architectural or phonograms	VI2R3C1	**YES**	**NO**	VI2R3C2
2.2 Copyright of software records	VI2R4C1	**YES**	**NO**	VI2R4C2
Industrial design records	VI2R5C1	**YES**	**NO**	VI2R5C2
Trademark registrations and other distinctive signs	VI2R6C1	**YES**	**NO**	VI2R6C2
5 Plant variety breeder certificates	VI2R7C1	**YES**	**NO**	VI2R7C2

Total intellectual property registrations obtained in the period 2017 - 2018 VI2R8C 2

VI.3 For each of the following options, indicate whether your company used other protection methods during the period 2017-2018, and specify the number of cases in which you used the appropriate method.

Total cases in which you used the 2017 - 2018 method

Other Methods of Protection

1 Industrial secret It is any undisclosed information that a natural or legal person legitimately possesses, that can be used in any productive, industrial or commercial activity and that is capable of being transmitted to a third party.	VI3R1C1	**YES**	**NO**	VI3R1C2
2 High complexity in design The company can strategically elaborate schemes, sketches or prototypes that describe ideas or objects of high industrial or commercial value, based on design techniques that make it difficult for competitors to copy or reproduce them.	VI3R2C1	**YES**	**NO**	VI3R2C2
3 Confidentiality agreements or contracts with other companies They are those in which two or more companies express their willingness to keep information confidential, in such a way that they undertake not to disclose, use or exploit the confidential information to which they have access by virtue of a contract or a specific task. (Count the different types of agreement or contract and not the number of times the same agreement has been signed)	VI3R3C1	**YES**	**NO**	VI3R3C2
4 Confidentiality agreements or contracts with employed personnel They are those in which two or more parties express their willingness to keep information confidential, in such a way that they undertake not to disclose, use or exploit the confidential information to which they have access by virtue of a contract or a specific task. (Count the different types of agreement or contract and not the number of times the same agreement has been signed)	VI3R4C1	**YES**	**NO**	VI3R4C2
Total other protection methods used in the period 2017 - 2018				VI3R5C2

VI.4 Did your company intend to apply for intellectual property registrations during the period 2017 - 2018?

YES ○ **NO** ○

VI.5 Point out the degree of importance that the following obstacles had, for the application or obtaining of intellectual property registrations by your company, during the period 2017 - 2018:

		Degree of importance		
		High	**Mediu**	**Null**
1 Lack of information on benefits and requirements 2 Difficulty meeting the requirements or completing the paperwork. 3 Excessive processing time	VI5R1C1 VI5R2C1 VI5R3C1			
3 Poor effectiveness of registrations to provide intellectual property protection	VI5R4C1			
4 Unfavorable cost-benefit balance	VI5R5C1			
5 No novel ideas are generated that are susceptible to obtaining intellectual property records	VI5R6C1			
6 Low internal capacity to manage intellectual property	VI5R7C1			

VI.6During the period 2017 – 2018, did your company obtain process quality certifications?. If yes, indicate how many.
(for example, if you have 2 processes with ISO-14040 and a process with ISO-9001, you must register 3 certifications)

Number of Certifications

○ **YES** **NO** ○ VI6R1C1

VI.7 During the period 2017 – 2018 did your company obtain product quality certifications?. If yes, indicate how many.
(for example, if you have 2 products with ISO-9000, you must register 2 certifications)

Number of Certifications

YES **NO** VI7R1C1

VI.8 Point out the degree of importance you had on the following aspects of your company, obtaining product or process quality certifications during the period 2017 - 2018:

		Degree of importance		
		High	**Medium**	**Null**
1 Generation of ideas to innovate	VI9R1C1	○	○	○
2 Increasing productivity	VI9R2C1	○	○	○
3 Increased access to national markets	VI9R3C1	○	○	○
4 Increased access to international markets	VI9R4C1	○	○	○
5 Greater technological update	VI9R5C1	○	○	○
6 Greater transfer of technology to the company	VI9R6C1	○	○	○
7 Better relationship with other companies in the sector	VI9R7C1	○	○	○

VI.9 Are the goods or services produced by your company during the period 2017 - 2018 subject to compliance with technical regulations?

CHAPTER VII - BUSINESS MANAGEMENT PERIOD 2018

Who should answer this chapter?
Staff engaged in the management of the company or production plant, familiar with the concepts of performance *indicators,* control boards or *follow-up boards in the company.*

VII.1 As of December 2018, who owns or major shareholders of the company? *(only option)*

1.1	Founder	VII1R1C1	○
1.2	Founder's Family Member		○
1.3	Other		○

VII.2 Is the company managed by the founder's a family member? *(only option)*

Manager: is the person who by trade is responsible for directing, managing or managing a company, company or entity. It is characterized by having employees who report directly and meet regularly, and could influence the decisions of promotions and pay rises of those employees. Example: Plant Manager, Human Resources Manager, Quality Manager.

2.1	Yes	VII2R1C1	○
2.2	No		○

VII.3 Indicate the gender of the person managing the company: *(only option)*

3.1	Man	VII3R1C1	○
3.2	Woman		○

VII.4 During 2018, what response best describes what happened in the company when a problem presented in its production processes?
Example: product quality problems or machinery failures, etc. (only option)

4.1	Fixed but no further action was taken	VII4R1C1	○
4.2	It was fixed and actions were taken to ensure that it did not happen again		○
4.3	Action was solved and taken to ensure that it did not happen again, and a process of continuous improvement was initiated to anticipate such problems		○
4.4	No action was taken		○

VII.5 During 2018, how many key performance indicators were monitored in the company? *(only option)*
Key performance indicators are measures used to quantify the degree of compliance with *the* goals *proposed by the company, thus reflecting the performance it performs. For example,* production *and post-production indicators, cost indicators, quality indicators, etc.*

5.1	1-2	VII5R1C1	○
5.2	3-5		○
5.3	6-9		○
5.4	10 or more		○
5.5	No se monitorearon indicadores clave de desempeño		○ *Skip to question 9*

VII.6 During 2018, how often were the key performance indicators reviewed by the managers in the company? (multiple option)

6.1	Annually	VII6R1C1	○
6.2	Quarterly	VII6R2C1	○
6.3	Monthly	VII6R3C1	○
6.4	Weekly	VII6R4C1	○
6.5	Daily	VII6R5C1	○
6.6	Every hour or more frequently	VII6R6C1	○
6.7	Never	VII6R7C1	○

VII.7 During 2018, how often were the company's key performance indicators reviewed by different busy staff than managers? *(multiple option)*

7.1	Annually	VII7R1C1	○
7.2	Quarterly	VII7R2C1	○
7.3	Monthly	VII7R3C1	○
7.4	Weekly	VII7R4C1	○
7.5	Daily	VII7R5C1	○
7.6	Every hour or more frequently	VII7R6C1	○
7.7	Never	VII7R7C1	○

VII.8 During 2018, where were control or monitoring boards placed to show the key performance indicators in the company? (only option)

8.1. All control or tracking boards were placed in a single visible location (for example: at the end of the production line)	VII8R1C1	○
8.2. Control or tracking boards were placed in multiple places (for example: at different stages of the production line)		○
8.3. No control or tracking boards were placed		○

VII.9 During 2018, which of the following best describes the timeline for production (only

Goals are all those objectives that the company establishes according to a calendar or time horizon, which are susceptible to be measured and which are in line with the purposes of the company. Example: Sales volume, production level, inventory level, service quality, efficiency, etc.

9.1	Short term (less than one year)	VII9R1C1	○
9.2	Long term (more than one year)		○
9.3	Combination of short- and long-term goals		○
9.4	There were no production goals		○ *Skip to question 16*

VII.10 During 2018, how easy or difficult was it for the company to achieve its production goals? *(only option)*

10.1	It was possible to achieve them withoutmuch effort	VII10R1C1	○
10.2	It was possible to achieve them with some effort		○
10.3	It was possible to achieve them with the normal amount of effort		○
10.4	It was possible to achieve them with a greater amount of effort than normal		○
10.5	It was only possible to achieve them with an extraordinary amount of effort		○
10.6	It was not possible to reach them		○

VII.11 During 2018, who knew the production goals in the company? *(only option)*

11.1	Only high-level directors and managers	VII11R1C1	○
11.2	Most managers and some productionworkers		○
11.3	Most managers and most productionworkers		○
11.4	All managers and most production workers		○

VII.12 During 2018, what criteria/s was the performance bonus policy usually established for staff occupied differently from managers? *(multiple option)*

12.1	Its own performance measured by the company's goals achieved	VII12R1C1	○
12.2	The performance of your team measured by the company's goals achieved	VII12R2C1	○
12.3	The performance of the establishment measured by the goals achieved	VII12R3C1	○
12.4	The performance of the company measured by the goals achieved	VII12R4C1	○
12.5	No performance bonuses were awarded	VII12R5C1	○ *Skip to question 14*

VII.13 *During 2018, when the company's goals were reached to some degree, what percentage of empl oyed personnel other than managers received a performance bonus? (only option)*

13.1	0%	VII13R1C1	○
13.2	1-33%		○
13.3	34-66%		○
13.4	67-99%		○
13.5	100%		○
13.6	Production targets were not met		○

VII.14 During 2018, what criteria were the performance bonus policy usually established for managers? *(multiple option)*

14.1	Its own performance measured by the company's goals achieved	VII14R1C1	○
14.2	The performance of your team measured by the company's goals achieved	VII14R2C1	⊗
14.3	The performance of the establishment measured by the goals achieved	VII14R3C1	
14.4	The performance of the company measured by the goals achieved	VII14R4C1	
14.5	No performance bonuses were awarded	VII14R5C1	○ *Skip to question 16*

VII.15 During 2018, when the company's goals were reached to some degree, what percentage of managers received a performance bonus? *(only option)*

15.1	0%	VII15R1C1	○
15.2	1-33%		○
15.3	34-66%		○
15.4	67-99%		○
15.5	100%		○
15.6	Production targets were not met		○

VII.16 During 2018, what was the main criterion by which the staff occupied differently from the managers were promoted in the company? *(only option)*

16.1	The promotions were based solely on their performance and ability	VII16R1C1	○
16.2	Promotions were based on performance and capacity, as well as other factors (e.g. seniority or family connections)		○
16.3	Promotions were mainly based on factors other than performance and capacity (e.g. seniority or family connections)		○
16.4	Busy staff other than managers are generally not promoted		○

VII.17 During 2018, what was the main criterion by which managers were promoted in the company? *(only option)*

17.1	The promotions were based solely on their performance and ability	VII17R1C1	○
17.2	Promotions were based on performance and capacity, as well as other factors (e.g. seniority or family connections)		○
17.3	Promotions were mainly based on factors other than performance and capacity (e.g. seniority or family connections)		○
17.4	Managers are generally not promoted		○

VII.18 During the year 2018, when was an employed person different from the person / s that manage due to poor performance reassigned or fired? (only option)

18.1	During the first 6 months once poor performance was detected	VII18R1C1	○
18.2	More than 6 months after poor performance was detected		○
18.3	Rarely or never		○
18.4	There were no underperforming staff		○

VII.19 During 2018, when was a manager reassigned or fired forpoor performance? (only option)

19.1	During the first 6 months once poor performance was detected	VII19R1C1	○
19.2	More than 6 months after poor performance was detected		○
19.3	Rarely or never		○
19.4	There were no underperforming managers		○