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INNOVATION MANAGEMENT ACTIVITIES AS EXPLANATORY DETERMINANTS OF THE INNOVATIVE PERFORMANCE OF INDUSTRIAL MSMES IN CORDOBA, ARGENTINA. CASE STUDY 2015-2020

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Summary. This research identifies the performance and management of innovation in micro, small and medium-sized industrial enterprises (MSMEs) in Córdoba, Argentina during the period 2015-2020. The information is taken from a questionnaire applied to 90 companies in the region. Two indices are created, one reflecting innovation management activities and the other reflecting innovation performance. A relevant number of companies assume positive results in their innovative performance, with product innovation and process innovation being the most significant, followed by organizational innovation and commercial innovation. Among the most important innovation management activities that show a low to moderate positive correlation with innovation performance are thepromotion of creativity, prioritization of innovation in business strategy, the design of a marketing strategy and activities related to internationalization, but their causality has not been demonstrated. An analysis that underlies the above is based on considering the multiple factors that affect both performance and innovation management indexes, which are part of a much more complex process strongly conditioned by the external and intrinsic context of the firms.

Key words: Innovation, innovation management, innovative performance.

LAS ACTIVIDADES DE GESTIÓN DE LA INNOVACIÓN COMO DETERMINANTES EXPLICATIVAS DEL DESEMPEÑO INNOVADOR DE LAS MIPYMES INDUSTRIALES EN CÓRDOBA, ARGENTINA. ESTUDIO DE CASO 2015-2020

Resumen. En esta investigación se identifica el desempeño y la gestión de la innovación en las empresas industriales micro, pequeñas y medianas (mipymes) de Córdoba, Argentina durante el periodo 2015-2020. La información se toma a partir de un cuestionario aplicado a 90 empresas de la región. Se crean dos índices, uno que refleja las actividades de gestión de la innovación y otro que refleja el desempeño innovador. Un relevante número de empresas asume resultados positivos en su desempeño innovador, siendo la innovación en productos y la innovación en procesos las más significativas, seguidas por la innovación organizativa y la innovación comercial. Entre las actividades de gestión de la innovación más importantes y que muestran correlacion positiva baja a moderada en el desempeño innovador, se destacan el fomento a la creatividad; la priorización de la innovación en la estrategia empresarial; el diseño de una estrategia de marketing y las actividades relacionadas con la internacionalización, sin embargo, no se demuestra su causalidad. Un análisis que subyace de lo anterior, se basa en considerar los múltiples factores que afectan a los índices tanto de desempeño como de gestión de la innovación y que forman parte de un proceso mucho más complejo y fuertemente condicionado por el contexto externo e intrínseco a las firmas.

Palabras clave: Innovación, gestión de la innovación, desempeño innovador.

Introduction

In a global, dynamic and technologically accessible context, the generation of value is strongly linked to the ability to adapt to this reality. Innovation is not a new concept and is recognized as an instrument capable of promoting the creation and maintenance of competitive advantages, especially if technological capabilities are accumulated and actions are implemented to manage a systematized, disciplined and continuous process.

Therefore, and assuming that innovation proposes to face challenges and risks, sometimes in contexts of great uncertainty, this research is concerned with exploring the implementation and management of innovation activities in industrial MSMEs in Córdoba during the period 2015-2020 as explanatory determinants of their innovative performance. The first challenge requires the design of a research instrument to investigate different innovation management activities and the results of the innovation process, and, based on the data obtained, to propose indicators that reflect the results achieved in a simple way, allowing the analysis of correlation between them.

This approach proposes to contrast, with an alternative approach to pre-existing studies, whether the implementation of systematized practices leading to the innovation process generates an impact on the innovative performance of the analyzed firms. Apparently, there are no studies of these characteristics in the region, so the results derived from this study are intended to be a contribution to the knowledge base applied to the design and execution of public policies and private strategies aimed at promoting the adoption and production of innovation that favor both the social and productive sectors.

Innovation

Numerous studies agree on the importance of innovation for the development of competitiveness in organizations. This is not a new concept; however, the different definitions of innovation that have been published at different times reveal how the concept has evolved. The latest editions of the Oslo Manual (OECD, 2005; OECD, 2018), are proof of this by incorporating to the technological innovations associated with products and processes, innovations of organizational and marketing type evidencing the dynamics and emphasis of their application.

Innovation is understood as a relevant component for economic and social progress, both at the level of organizations and nations. Its management is vital and forms part of the critical processes of any organization. According to Canizales Muñoz (2020), in contemporary trends framed in globalization, innovating is a daily task, which develops from a dynamic, continuous and non-seasonal process. It is an interactive process, the results of which depend on the relationships between different companies, organizations and sectors, as well as on institutional behaviors deeply rooted in each regional or national history (Johnson and Lundvall, 2003).

Thus, the innovation process can be analyzed as the result of collective learning, a consequence of collaborations within the company and between the company and other organizations (Cassiolato et al., 2014). Rojo-Gutiérrez et al. propose the same. (2019), considering that the view of innovation as a process highlights the role of the company, whether to deploy activities in the management of new ideas or in knowledge management, the focus of its importance is concentrated on the benefits it generates through its results.

Innovation management

Based on the definitions of the Virtual Observatory of Technology Transfer (OVTT) (n.d.), and Orozco Barrantes et al. (2017), we will say that it is the managerial capacity over economic and human resources, towards the creation of new ideas and knowledge that allow the development of new products, processes and services or the improvement of existing ones, and the transfer of those same ideas to the manufacturing, distribution and use phases. Several authors, from the most classical to contemporary, highlight the importance of managing innovation, mainly under the premise that order, discipline, monitoring and control in a complex and interactive process are key to obtaining the expected results (Drucker, 1985; Ponti and Ferras, 2008; Seclen Luna and Barrutia Güenaga, 2019; Tidd and Bessant, 2018).

The study of innovation and its management has been complemented with proposals for management models that formulate simplifications of reality in order to be applied and studied. Although they do not offer a universal solution, they facilitate the explanation of a complex reality and the transmission of experiences that can serve as a reference. As progress has been made in the learning and appropriation of the innovation process, models have tried to adapt to the needs and realities of organizations, contemplating their circumstances and singularities, going from being linear models to interactive and networked models, however, many focus on describing the process, rather than defining how to promote the development of the capabilities that the organization has to innovate (García Leonard and Sorhegui Rodríguez, 2020), since these arise from a gradual and cumulative learning process, which accompanies organizational maturity.

Supported by the paradigms proposed by the theory of innovation management models, there are several researches oriented to study and formulate practical models

(Cooper, 2005; Tidd, Bessant and Pavitt, 2005; Trías de Bes and Kotler, 2011; Güell, 2014; Comunidad Design Thinking en español, 2019; Tidd and Bessant, 2018; Chesbrough, 2020). In this research, it takes as reference the one proposed by Tidd and Bessant (2018), who present a simplified model of the innovation process divided into 4 stages: a). search for signals from the environment, b). selection of technological or market opportunities, c). implementation of the innovation, and d). capture of the benefits of innovation.

Figure 1. Innovation management model Source: Adapted from Tidd and Bessant (2018).

We highlight from this proposal the existence of an initial stage leading to the search for innovation opportunities, with the possibility of directing efforts to the open search in the internal and external environment of the organization, giving rise to the generation of ideas from creative processes and the detection of demands and opportunities gathered from the contact networks with other organizations in the environment. The contributions of Rojo-Gutiérrez and Padilla-Oviedo (2018) stand out here, by emphasizing the participation of the individual over the company; the latter being the source and generator of ideas through his creativity and restless attitude in bringing about change. Finally, the management model analyzed contemplates the delivery of value to the client, given that its last stage of value capture could be understood not only as the obtaining of a new product or service, but also with its delivery to the recipient and the appropriation of its results.

Despite the existence of different models, there is no consensus on a single and fully explanatory model of the process that an invention goes through from the time it is developed and brought to market, as suggested by different authors (Tidd et al., 2005; Du Preez and Louw, 2008; Seclen Luna and Barrutia Güenaga, 2019; García Leonard and Sorhegui Rodríguez, 2020), this due, among other factors, to the heterogeneity among companies, their different routines, competencies, capabilities and strategic objectives, however, a series of standard activities that could be applied in different companies stand out.

Innovative performance

We will refer to innovative performance as the result of the innovation process, being the determination of its measurement one of the main concerns of current business management (Arévalo Tomé et al., 2013). The challenge of measuring the impact of innovation activities, proposes to define indicators; in particular, a performance indicator is presented as an instrument for measuring the main variables associated with the fulfillment of objectives, being also a quantitative and/or qualitative expression of what is intended to be achieved (García Cediel and Castillo Bautista, 2016).

In order to design an indicator that reflects innovative performance, it should be mentioned that it can be oriented to different aspects and methodologies, according to the context in which it is to be implemented. Based on this, different works have been examined that expose different perspectives on how to approach the measurement of innovative performance, among which stand out those oriented towards the product (Córdoba Vega and Naranjo Valencia, 2017; Arias Pérez and Lozada, 2018; Coaquira Nina et al., 2019; Quinteros Camacho et al., 2019), from those that take other relevant dimensions such as process performance, capabilities, resources, and social and environmental responsibility (Gecheng et al., 2021salaiza et al., 2020; Shahla et al. 2020; Vega Sampayo et al., 2020; Valencia-Rodríguez, 2015; Garcia Velázquez et al. 2015, Arévalo Tomé et al., 2013; Canizales Muñoz, 2020).

Other recent studies, complementarily, emphasize the analysis of firms' innovative performance through the number of published patents (Chen, Chen and Vanhaverbeke, 2011; García et al., 2013; Sánchez Muñoz 2014) and on firms' linkage and cooperation processes with external organizations (Parrilli and Heras, 2016; Vélez et al., 2019; UNESCO, 2017; Radicic et al., 2019; Parrilli et al., 2020).

Method

A case study was chosen as the research methodology. The collection of data on the study variables is obtained from the design and application of a questionnaire that is chosen as an appropriate research instrument to contact the MSMEs that are key references. Subsequently, the method for systematizing the data is outlined, the most significant data are selected and a unit of measurement used to analyze the correlation of the variables chosen is designed.

Based on the correlation analysis, it is expected to provide an answer to the question: What are the innovation management activities implemented by industrial MSMEs in Córdoba, Argentina, and to what extent do they explain their innovative performance?

The research design presents a mixed, non-experimental and correlational-causal approach and is aimed at verifying the proposed hypothesis:

- H0: Innovative performance is not better among companies that implement innovation management activities in a systematized way.
- H1: Companies that implement innovation management activities in a systematized way obtain better results in their innovative performance than companies that do not

Case study

The study is conducted in companies classified as industrial MSMEs, according to Resolution 220/2019 (SECPYME, 2019), located in the province of Córdoba, Argentina. On the other hand, the companies that are active and registered in the Industrial Information System of Cordoba (SIIC, 2019), in the 2019 operating year, were considered. The selected companies are invited to participate in a questionnaire to collect information on the variables analyzed in the research. The results presented here are part of a pilot study on a sample of 90 companies from different sectors of activity and location in the province, which seeks to test the validity of the methods and procedures used.

Variables

The variables proposed for the study are: innovation management activities (independent variable of a qualitative nature) and innovation performance (dependent variable of a qualitative nature). Tables 1 and 2 specify the variables in order to identify the dimensions for their measurement.

Table 1

Variable operationalization matrix Innovation Management Activities

Variables	Conceptual Definition	Dimensions	Indicators Operational definition
INNOVATION MANAGEMENT ACTIVITIES Independent variable	Activities, methods or processes aimed at increasing the creation of new knowledge, generating ideas to develop new products, processes and services or improve existing ones, and the transfer of these same ideas to the manufacturing, distribution and use phases.	Search for innovation opportunities	Internal input of ideas.
			Contribution of external ideas.
			Evaluation of ideas.
			Application of ideas.
			Encouragement of creativity.
			Technology Watch
			Market research.
		Opportunity selection	Innovation strategy.
			Market validation.
			Formulation of innovation projects.
			R&D activities.
			Investment in Technology.
			Implementation or application of quality systems.
		Innovation implementation	Management of financial resources for innovation projects.
			Project management.
			Knowledge management.
			Relationship with universities, innovation centers, specialized consultants.
			Marketing strategy.
		Value capture	Internationalization.
			Intellectual property.
			Interaction with other companies.

			Post-launch innovation follow-up.

Note: The study variable Innovation Management Activities is conceptually and operationally defined based on Tidd and Bessant (2018). Source: Own elaboration based on Cohen and Gómez (2019).

Table 2
Operationalization matrix of variable Innovative performance

Variables	Conceptual Definition	Dimensions	Indicators Operational definition
INNOVATIVE PERFORMANCE *Dependent variable*	Results of the innovation process.	Product innovation	Market introduction of new product/service.
			Introduction to the market of significant improvements in existing products/services.
		Innovation in process	Introduction of new production method.
			Introduction of new distribution method.
			Significant improvement of processes related to the environment.
		Commercial innovation	Introduction of new marketing method.
			Introduction of new design or presentation of the product/service.
			Introduction of innovative pricing and promotional policies.
		Organizational innovation	Introduction of a new organizational method applied to business practices.
			Introduction of a new method of work organization.
			Introduction of external relations of the company.

Note: The study variable Innovative Performance is defined conceptually and operationally, based on the classification of innovation proposed in OECD (2018). Source: Own elaboration based on Cohen and Gómez (2019).

From the data obtained, we seek to establish the correlation between the variables. For the particular case, and under the assumption that the distribution is not normal, the Spearman's rank correlation coefficient (Rho) is determined, being a measure of

correlation for variables at an ordinal level of measurement, where individuals or sample units can be ordered by ranks (Hernández Sampieri et al., 2014).

Considering the most influential factors that emerge from the aforementioned correlation, a quantitative indicator is designed for each of the variables, called: Innovation Performance Index (IDI) and Innovation Management Activities Indicator (AGI). The construction of these indexes makes it possible to generate a *ranking* among the participating companies, to order them according to their innovative performance through IDI and to analyze their behavior.

Research instrument

To collect the required data, a specific instrument was designed, for which the background of previous studies provided relevant information on the methods and practices used. This is a questionnaire that is distributed among the selected MSMEs. For the design of the instrument, the proposal of agile and closed questions and statements was taken into account in order to facilitate participation. The questionnaire was structured in three sections: I- general data related to the company; II- implementation of innovation management activities; and III- innovative performance of the firm. Given the characteristics of the issues to be investigated, the instrument is oriented to the strategic level of the organization.

In order to determine the validity of the instrument, it was initially applied to a technology-based company with a recognized innovative trajectory, with the purpose of evaluating its applicability and functionality, as well as the opinions of experts. Likewise, Cronbach's alpha reliability statistic was used to determine internal consistency.

Parameterization of variables

In order to evaluate the independent variable, a Likert-type scale was applied, as a set of items presented in the form of statements that seek to measure the subject's reaction in categories (Hernández Sampieri et al., 2014). For the purpose of designing the aforementioned statements, the innovation management model proposed in Tidd and Bessant (2018) has been taken as a reference. A set of statements aimed at assessing the respondent's perceptions is formulated on a qualitative scale and then translated into a quantitative equivalence with possible values of: 1 to 5, with 1 being the minimum or null and 5 the maximum.

According to the stages proposed by the model, innovation management activities were classified as follows: I- Search for opportunities for innovation; II- Selection of opportunities for innovation, III- Implementation of innovation and IV- Capture of value from innovation. Based on this, a total of 22 assertions were made. The responses were oriented to assess the respondent's perceptions according to different criteria.

Table 3
Scale for measuring the qualitative variable AGI.

Appraisal criterion	1	2	3	4	5
Agree or disagree	Strongly disagree	Disagreement	Undecided	Agreed	Totally agree
Frequency	Null	Download	Media	High	Very high
Importance	Unimportant	Minority	Moderately important	Important	Very important
Level or degree of valuation	Null	Download	Media	High	Very High

Note: Own elaboration based on Cohen and Gómez (2019).

Regarding the dependent variable, closed questions were proposed on aspects related to the outcome of the innovative process, taking into account the classification of innovation presented in the Oslo Manual (2018). This classification has been chosen because of its application in various studies and settings, with the understanding that it facilitates comparability between studies, as well as its applicability to other research.

Specifically, to study this variable, questions were designed and asked about the 4 categories of innovation, according to their classification as: I- Product innovation; II- Process innovation; III- Commercial innovation; and IV- Organizational innovation. On this basis, a total of 11 questions were posed. The possible answers were defined in a closed manner and are intended to eliminate or reduce the subjective perception of the respondent, so that the answer is conducive to defining the achievement, or not, of innovative results. The possible answers are: "Yes", "No", "In process". It is worth noting the mention of the response "In process", with the understanding that companies that did not achieve results, but are in the process of achieving them, require a differentiated valuation, in line with the definition of potentially innovative firms identified in the Bogota Manual (Jaramillo et al., 2001).

Table 4
Rating scale of the dependent variable

Factors	*Subfactors*	*Possible answers*	*Quantitative valuation*
F1: Product innovation	F1.1: New products	Yes	3
	F1.2: Significant improvements to existing products.	No	1
		In process	2
F2: Innovation in Process	F2.1: New processes.	Yes	3
	F2.2: Significant process improvements	No	1
	F2.3: Improvements to reduce environmental impact or working conditions	In process	2
F3: Commercial Innovation	F3.1: New marketing methods	Yes	3
	F3.2: Improvements in product design or presentation.	No	1
	F3.3: New pricing policies and promotions.	In process	2
F4: Organizational Innovation	F4.1: New organizational methods applied to business practices.	Yes	3
	F4.2: New methods of work organization.	No	1
	F4.3: External relations	In process	2

Note: Own elaboration based on Cohen and Gómez (2019).

In summary, among the 22 statements related to innovation management and the 11 questions related to innovative performance, 33 responses were obtained for each of the companies that participated in the study and, for each one, quantitative values were assigned as detailed in Tables 3 and 4, above.

Data analysis.

The data obtained in the defined collection process were coded and transferred to an error-free matrix for analysis. This required the application of *software* for statistical analysis, in this case the InfoStat program (InfoStat, 2020). Based on the most influential aspects of the variables under study provided by the correlation analysis, we proceeded to design a quantitative indicator representative of each of the variables quantitative indicator representative of each of the variables: Innovative Performance Index (IDI) and Innovation Management Activities Indicator (AGI), defined as follows:

$$AGI_i \equiv \sum_{j=1}^{4} \sum_{k_j=1}^{M_j} \left(g_j * w_{k_j} * X_{k_j,i} \right)$$

Where:
AGIi= Innovation Management Activities Indicator of company i;

j = 1: "A- Innovation opportunities," 2: "B- Selection of innovation opportunities", 3: "C- Implementation of innovation," 4: "D- Value capture of innovation."
kj = question number k of factor j;
Mj = total number of questions associated with factor j;
gj = weighting value of factor j in AGIi;
wkj = weighting value of question kj in relation to factor j;
Xkj, i = value of company i's response to question kj.
Then, the weights of each of the j factors being equivalent to each other:
$\sum_{j=1}^{4} g_j = 1$with: g1 = g2 = g3 = g4 = ¼,
the weightings of each question in relation to factor j are also equivalent to each other:
$\sum_{k_j=1}^{M_j} w_{k_j} = 1$; with: wkj = 1/Mj (∀j),
and defining:

$$x_{j,i} = \sum_{k_j=1}^{M_j} \left(\frac{X_{k_j,i}}{M_j} \right)$$

as the simple average of the values of company i's answers to the questions associated with factor j;
we can then express AGIi as:

Equation 1
Indicator of Innovation Management Activities - AGI

$$AGI_i = \frac{\sum_{j=1}^{4} (x_{j,i})}{4}$$

The results obtained for this indicator will be between 1 and 5, indicating its qualitative assessment and its quantitative correspondence, according to the following table:

Table 5
Quantitative equivalence of AGI

Qualitative assessment	Quantitative valuation
Very high	5
High	4
Moderate	3
Under	2
Very Low - Nil	1

Note: Own elaboration.

IDI Formula

$$IDI_i \equiv \sum_{p=1}^{4} \sum_{q_p=1}^{H_p} \left(d_p * w_{q_p} * Y_{q_p,i} \right)$$

Where:
IDIi= Innovative performance index of company i;

p = 1: "A- Product innovation", 2: "B-Innovation in process," 3: "C- Commercial innovation", 4: "D- Organizational innovation;
qp = question number q of factor p;
Hp = total number of questions of factor p;
dp = weighting value of factor p in the IDIi;
wqp = weighting value of question qp in relation to factor p;
$Yqp_{,\,i}$ = value of company i's response to question qp.
Therefore, the weights of each of the p factors being equivalent:
$\sum_{p=1}^{4} d_p = 1$with: d1 = d2 = d3 = d4 = ¼,
the weightings of each question in relation to factor j are also equivalent to each other:
$\sum_{q_p=1}^{H_p} w_{q_p} = 1$; with: wqp = 1/Hp (∀p),
and defining:

$$y_{p,i} = \sum_{q_p=1}^{H_p} \left(\frac{Y_{q_p,i}}{H_p} \right)$$

as the simple average of the values of company i's answers to the questions associated with factor p;
we can express the IDIi as:

Equation 2
Innovative Performance Index IDI

$$IDI_i = \frac{\sum_{p=1}^{4} (y_{p,i})}{4}$$

The results obtained for this indicator will be between 1 and 3, indicating its qualitative assessment and its quantitative correspondence, according to the following table:

Table 6
IDI quantitative equivalence

Qualitative assessment	Quantitative valuation
High	3
Medium	2
Null	1

Note: Own elaboration based on Cohen and Gómez (2019).

Results

The research instrument designed for the study is evaluated as reliable according to the internal consistency analysis obtained through the Cronbach's Alpha reliability statistic, which yields a value of 0.9473. After its application in 90 companies, a descriptive statistical analysis of each of the variables under study was carried out. Subsequently, an inferential statistical analysis was performed to determine the potential for a significant correlation between the two variables, inferring whether and to what extent the implementation of innovation management activities explains the results in innovation performance.

Descriptive statistical analysis

Innovation Management Activities

In order to describe the results obtained on the application of innovation management activities, an analysis of each of the stages of the process is presented.

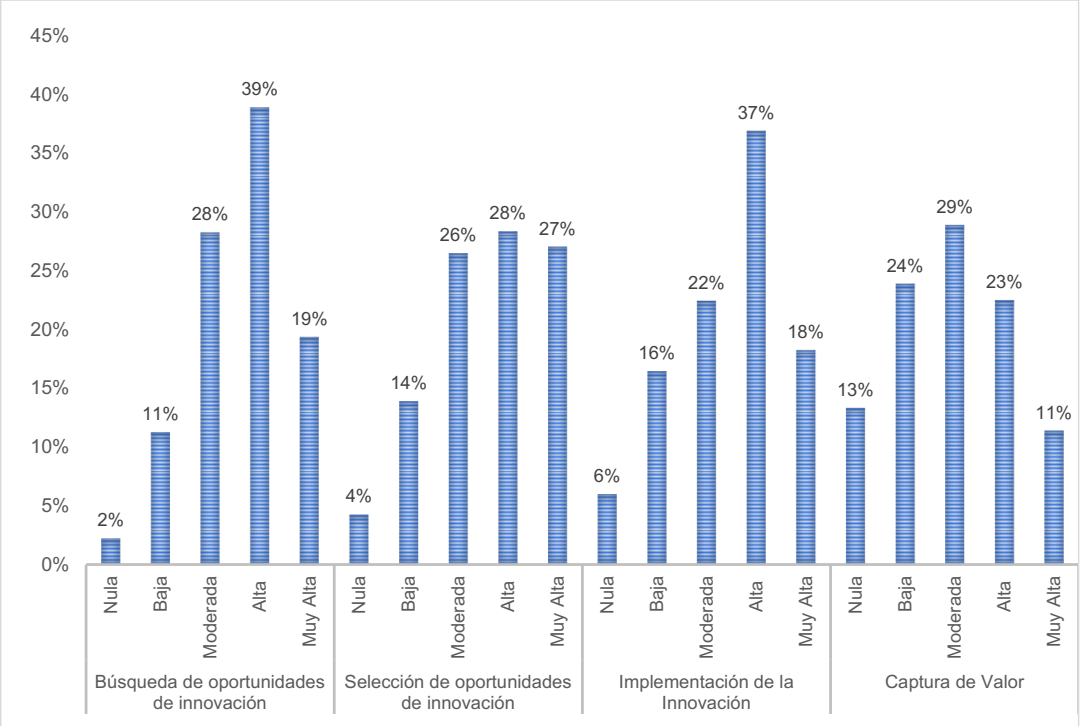

Figure 2. Descriptive analysis of IGAs

Highlighting the "high" and "very high" ratings for each of the aspects, it can be seen that, on average, the implementation of innovation management activities is uniformly applied among the companies analyzed. Actions related to the search for innovation opportunities are valued as the most frequent and important (58% of the companies analyzed), while the selection of innovation opportunities and implementation of innovation represent 55% in both cases, however, the actions of selection of opportunities are distinguished, since the "very high" valuation is higher in comparison with the implementation actions. Actions related to value capture are among the least valued and least frequent for this group of companies, with "high" and "very high" ratings occurring in only 34% of the cases, while 37% of the ratings are "null" and "low".

Indeed, it stands out, taking the "high" and "very high" ratings, that the importance and frequency in the implementation of actions related to innovation management is ordered as: 1- Search for Innovation Opportunities, 2- Selection of Innovation Opportunities, 3- Innovation Implementation and 4- Innovation Value Capture. The following graph shows more clearly the order of weightings referred to above.

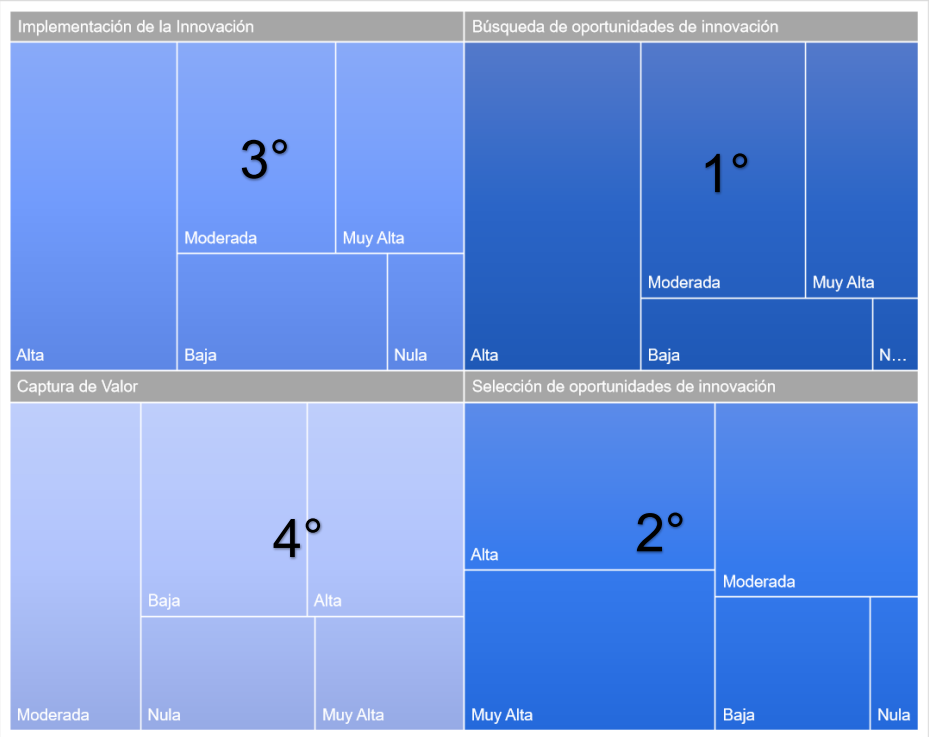

Figure 3. Order of relevance of the IGA valuation

Innovative performance outcome

In order to describe the results related to innovative performance for the 90 participating companies, the analysis by type of innovation proposed for the operationalization of this variable is presented.

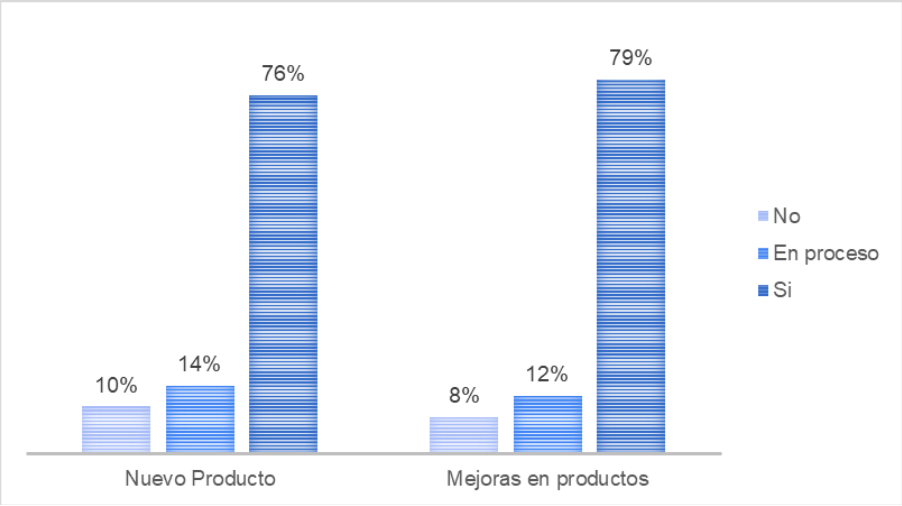

Figure 4. Product innovation

The results support a good innovative performance, with more than 90% of companies having implemented product innovations or being potentially innovative.

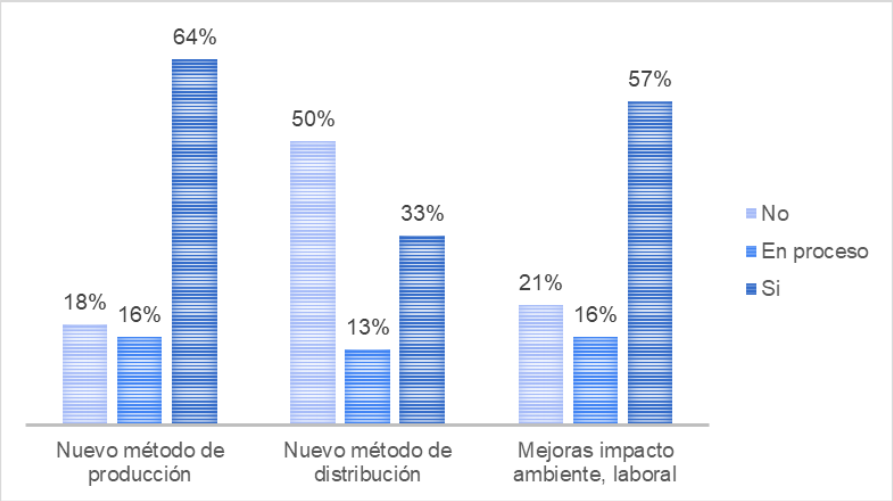

Figure 5. Process innovation

The information obtained shows a high percentage of companies that innovate in production methods and processes that result in better environmental and labor performance, or are in the process of doing so. The lesser focus on innovation in new distribution methods is significant.

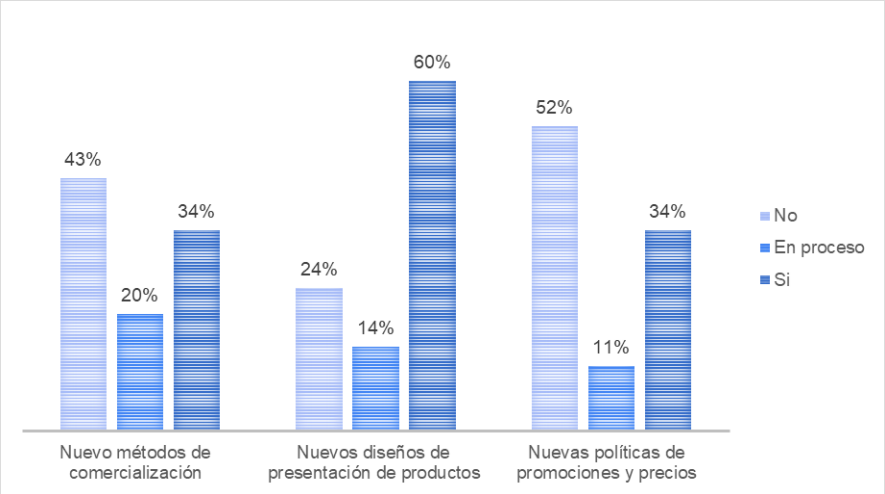

Figure 6. Commercial innovation

It is highlighted that, for commercial innovation, about half of the companies are innovative or potentially innovative and the other half have not achieved results in that aspect.

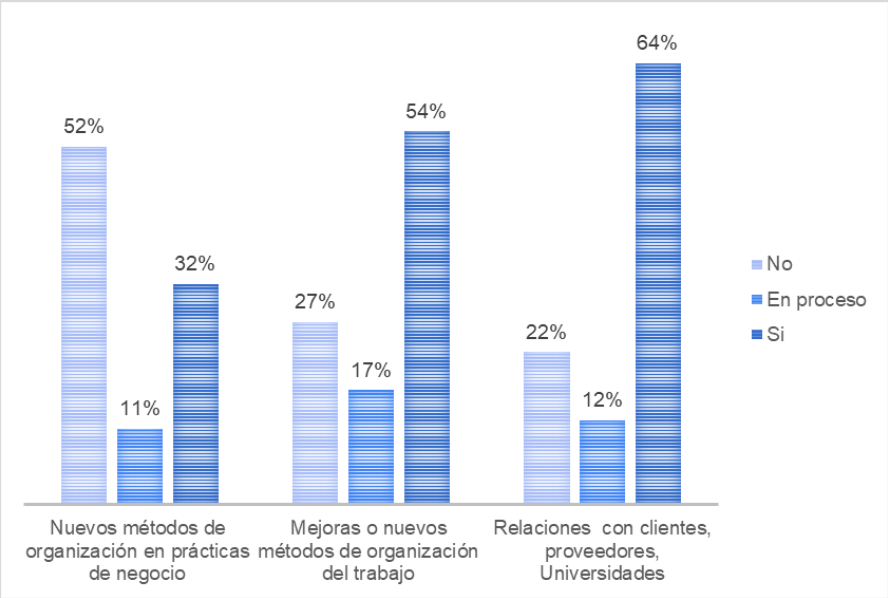

Figure 7. Organizational innovation

It is observed that organizational innovation is mostly oriented to the relationship with actors of the innovation system and to introduce improvements in work organization methods.

In order to obtain an overall view of the innovative performance variable and to highlight preliminary conclusions, a better innovative performance is observed in the following order: 1- Product innovation, 2- Process innovation, 3- Organizational innovation and 4- Commercial innovation, graphically represented below.

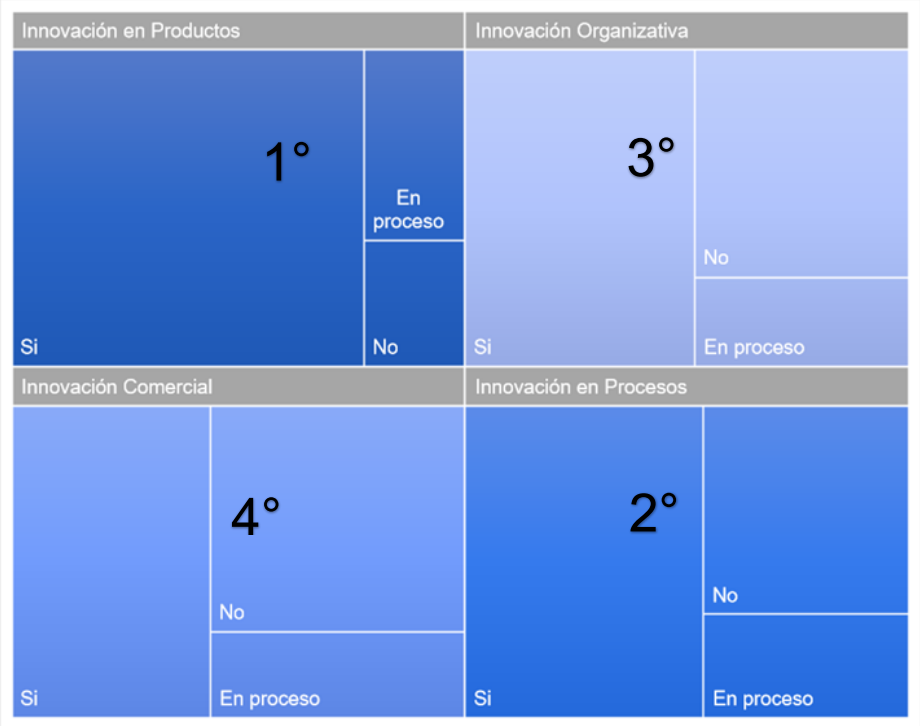

Figure 8. Ranking order of Innovative Performance by type of innovation

A first conclusion from the descriptive analysis suggests that, at the aggregate level, there is a relevant weighting of the different factors proposed to measure innovation

management activities, as well as innovative performance. In the analysis proposed below, we will seek to infer the correlation between the variables.

Inferential statistical analysis

Correlation coefficient

Having corroborated, through the Lilliefors test based on the Kolmogorov-Smirnov goodness-of-fit test , that the variables do not have a normal distribution, the Spearman correlation nonparametric statistical test was applied , obtaining a matrix of 242 data from the association of the 22 questions proposed for the independent variable and 11 for the dependent variable. On this basis, the most influential or significant relationships or associations were determined, using the critical Rho, which, for a sample size of 90 and a significance level of 0.05, is 0.207.

It is noted that, in most cases, there is a positive correlation; however, most of the associations are considered weak or statistically insignificant, with the value of the correlation coefficient below the critical coefficient. Of the 242 associations, 79 are above the critical Rho, i.e. 32.65%.

In order to reduce the information subject to analysis, the sub-factors of the independent variable considered irrelevant were eliminated from the original matrix, applying the criterion of discarding the sub-factors whose simple averages of their correlation coefficients are less than 0.207. Thus,a reduced correlation matrix is presented. Hereafter, this information will be used to advance the proposed inferential model.

Table 7
Reduced Correlation Matrix

	Independent Variable - Factors	**AGI A**	**AGI B**	**AGI C**	**AGI D**
Dependent Variable - Factors	**Sub-Factors**	Encouraging creativity	Innovation in business strategy	Marketing strategy	Internationalization.
Product Innovation	New products.	0.190	0.230	0.150	0.100
	Significant improvements to existing products.	0.150	0.300	-0.030	0.150
Innovation in Process	New processes.	0.250	0.300	0.060	0.320
	Significant process improvements.	0.240	0.180	0.310	0.360
	Improvements to reduce environmental impact or labor conditions.	0.230	0.180	0.190	0.150
Commercial Innovation	New marketing methods.	0.190	0.160	0.320	0.270
	Improvements in product design or presentation.	0.120	0.120	0.150	0.080
	New pricing policies and promotions.	0.180	0.260	0.380	0.130
Organizational Innovation	New organizational methods applied to business practices.	0.280	0.280	0.350	0.430
	New methods of work organization.	0.270	0.170	0.140	0.230
	External relations with clients, suppliers, universities, etc.	0.240	0.100	0.190	0.300

Note: Correlation between IDI and AGI of highest significance.

IDI and AGI indicators

Based on the application of the formulas developed for each variable (Equation 1 and Equation 2), the values of each indicator were calculated for each of the companies surveyed. The results obtained are presented graphically, ordered by company, according to their highest IDI and corresponding AGI.

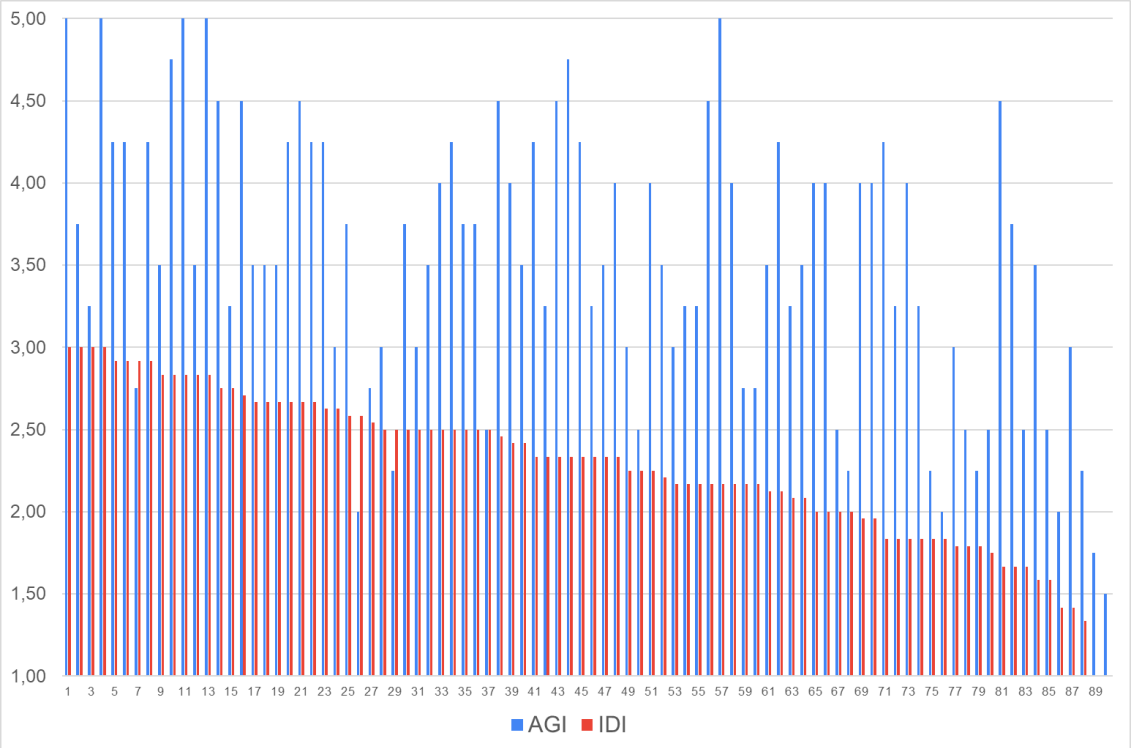

Figure 9. Ranking of companies according to IDI.

The information available makes it possible to explore, by using the statistical tool of linear regression analysis, whether the results obtained fit a linear equation, attempting to reflect the behavior of the companies in relation to the problem posed, contrasting the proposed hypothesis. These results are presented below.

Table 8
Linear regression analysis

Variable	N	R^2	R^2 Adj	ECMP	AIC	BIC
IDI	90	0.27	0.26	0.26	0.16	90.86	98.36

Coef	Est.	E.E.	LI(95%)	LS(95%)	T	p-value	CpMallows	VIF
const	1.29	0.18	0.94	1.64	7.26	<0.0001		
AGI	0.28	0.05	0.18	0.38	5.72	<0.0001	33.31	1.00

Note: Linear regression analysis using InfoStat, (2020).

Based on this information, it is possible to define the following equation:

Equation 3

$$\mathcal{Y} = 1{,}29 + 0{,}28 * x$$

Where:

$\mathcal{Y}$=IDI

x = AGI

It is observed that, although it is not a determining factor, it shows an explanatory tendency for the phenomenon studied. Graphically, from the visualization of the dispersion we obtain:

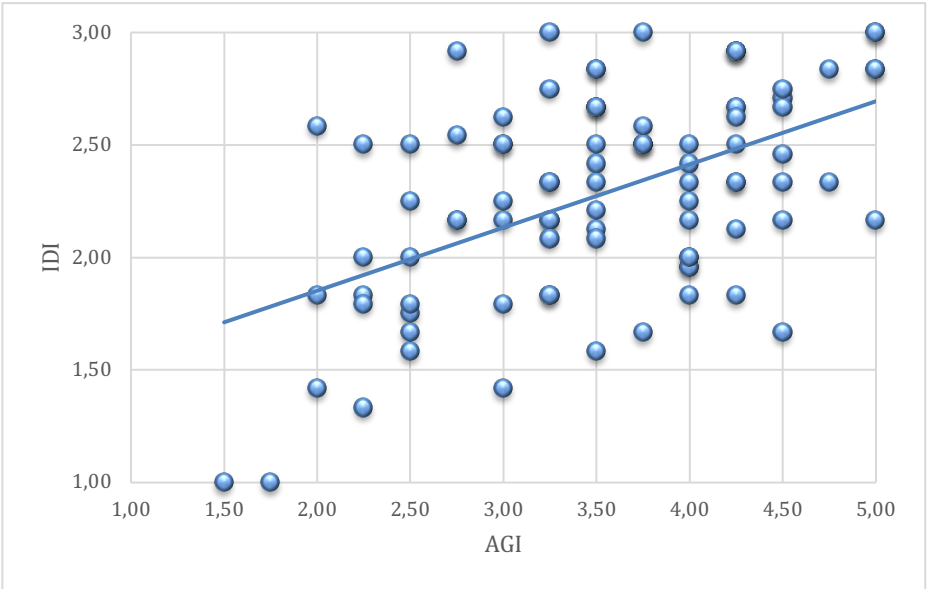

Figure 10. Scatter plot of the results. Linear regression analysis

Discussion and conclusions

The preliminary studies proposed for this research expose the relevance of accumulating scientific knowledge on innovation, particularly in its application and results. It is also necessary to consolidate regional studies that allow comparisons with other regions, assuming that different cultures, social realities, geographic and economic conditions may lead to dissimilar results, even in the face of equivalent strategies.

On the other hand, research oriented towards real cases contributes to the analysis of current dynamics and circumstances, while proposing a structured and rigorous knowledge base on which to base the design of innovation-oriented public policies, as well as business strategies, based on the study of their own realities rather than attempting to extrapolate actions and results derived from external experiences.

From the descriptive analysis of the study variables, it can be seen, on the one hand, a good assessment in the application of innovation management activities among the companies studied, highlighting the activities related to the search for innovation opportunities as those with the highest application, followed by those related to the selection of innovation opportunities, implementation and value capture. On the other hand, a relevant number of companies assume a good performance in their innovative performance, being product innovation and process innovation the most significant, followed by organizational and commercial innovation.

Returning to the research question, the pilot study presented here makes it possible to put the proposed methodology into practice and reach the first conclusions on the question formulated. It can be seen from the results obtained that the activities promoting creativity, prioritizing innovation in business strategy and designing a marketing strategy show a positive correlation in innovative performance, although it is low, while the activities related to internationalization in companies show a moderate positive correlation, although causality has not been demonstrated.

In the hypothesis test, the null hypothesis is rejected, since the results show an explanatory trend for the phenomenon studied, although it is not decisive. An analysis that underlies the above is based on considering the multiple factors that affect the

variables, being a much more complex process and strongly conditioned by the external and intrinsic context of the firms, concluding that the execution and management of innovative activities does not constitute, by itself, a causal factor of the innovation index achieved.

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