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Relationship Between the Factors that Influence the Management of Innovation in the Manufacturing Industry of Pichincha, Ecuador

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Abstract

Among the difficulties in understanding the lack of innovation in the Ecuadorian business sector is the absence of knowledge of those critical variables and their relationships on which good innovation management depends. The objective of this article is to determine the relationships that exist between the relevant factors present in the management of innovation in the manufacturing industry, the results of which will allow a better understanding of the problem and will provide insights to execute plans focused on increasing innovation. To identify the relationships between the existing relevant factors in innovation management, we start from a theoretical model made up of three main constructs or categories that interact with each other, which are: knowledge management (KM), innovation capabilities (IC), and financial performance (FP). To explain the model and determine the relationship between the constructs, some hypotheses are proposed, which are tested through multivariate statistical analysis. The scope of study is medium-sized manufacturing companies in the province of Pichincha in Ecuador. This research has a quantitative approach, it is correlational and non-experimental. As a result, it was shown that there is a significant, positive, and direct correlation between KM, IC, and FP, and that the increase in innovation in the industry depends on improving the educational level of the staff, communication between employees, cooperation and teamwork, staff incentives, employee commitment to the company's objectives, the amount of investment in RD, efficiency, product quality and the awareness of business managers about the importance of properly managing innovation. This study is a pioneer in empirically analyzing the systemic relationship between the relevant components of innovation management in the manufacturing industry of Ecuador. The contribution of this article is to empirically verify that innovation management constitutes the management of a complex system in which knowledge management and innovation capabilities play a fundamental role in achieving the financial performance expected by companies.

Keywords: financial performance, innovation capabilities, innovation management, knowledge management, manufacturing industry.

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1 Introduction

In the business context, innovation represents the means to create new economic value through the development of novel products, the application of efficient production methods, and the generation of sales (Nakamori, 2020; Zawislak et al., 2018). This method of generating economic value requires effective management to attain business objectives.

According to the Global Innovation Index, Ecuador ranks ninety-first in the world and twelfth in the Latin American and Caribbean (LAC) region (Dutta et al., 2021). These positions show that the business sophistication pillar of the innovation index has a low valuation, which demonstrates how little innovation exists in the Ecuadorian business environment. This statement agrees with the latest innovation survey in Ecuador, which determined that only 54.5% of Ecuadorian companies carry out some type of innovation (product, process, organizational, or marketing) (SENESCYT-INEC, 2015).

The lack of innovation is a problem that affects the competitiveness and sustainability of business organizations in developing countries (Qin, 2024) and particularly the Ecuadorian industry in the context of the knowledge economy (Aguilar-Barceló & Higuera-Cota, 2019; CEPAL, 2016). This problem is addressed in this research from the field of study of innovation management (IM) in the industry.

In the theoretical field and in several empirical studies, IM has been explained as a cause-effect relationship between specific organizational factors and innovation processes (Melendez et al., 2019). For example, it includes the relationship between intellectual capital and innovation (Buenechea-Elberdin et al., 2017; Costa et al., 2014; Elia et al., 2017); the relationship between explicit and tacit knowledge strategies with innovation (Davila et al., 2019; Magnier-Watanabe & Benton, 2017; Ode & Ayavoo, 2020); the relationship between technological intensity and innovation capacity (Zawislak et al., 2018); the relationship between organizational culture and innovation (Chang et al., 2017); the relationship between suppliers and customers to improve innovation (Delgado-Verde et al., 2014); the relationship between dynamic capabilities and innovation (Farhana & Swietlicki, 2020; Kaur, 2019; Salmador et al., 2021), among others.

As such, the motivation of this research is to study IM as the management of a complex system, surpassing the vision of IM as the planning, execution and control of activities that are related in a simple way and as cause – effect. This new complex system proposed, unlike those simple relationships between organizational factors and innovation processes, incorporates multiple organizational factors that interact by establishing a set of dependency relationships between latent variables or constructs and their corresponding measurable factors.

Therefore, the objective of this research is to evaluate the relationships that exist between the constructs and factors that form the IM, taking as a starting point a IM model obtained from an investigation of the manufacturing industry of Pichincha in Ecuador (Ibujés-Villacís & Franco-Crespo, 2022). This model has a holistic, systemic approach and is integrated by three multidimensional reflective constructs: knowledge management, innovation capabilities and financial performance. To determine the relationships between the constructs of the model, a set of hypotheses were proposed, in order to verify the correlation between the constructs and each of their factors.

The contribution of this article is to have determined that IM consists of the management of a complex system, in which there is a significant, positive and direct relationship between knowledge management and financial performance, between knowledge management and the capabilities of innovation and between innovation capabilities and financial performance. In addition, those relevant factors that must improve the manufacturing industries of Pichincha were identified to positively impact the increase in innovation. These results, with certain reservations, can be generalized in the Ecuadorian industry given the similar characteristics of its business fabric.

The article begins with an overview of the systemic organization and management of innovation which consists of three constructs. Next, an IM model is proposed, and hypotheses are formulated about the relationship between these constructs. In the second part, the hypotheses are tested

using multivariate statistical analysis. Finally, the article presents a discussion of the results and conclusions with limitations and possible future studies.

2 Theoretical elements

In this section, key concepts related to the theoretical support of this research are analyzed.

2.1 The organization and innovation management

Innovation has evolved from a linear model, proposed as the succession of basic and applied research, and technological development activities conducted by the research and development department of organizations, to a systemic model. As a result of this transformation, the processes involved in innovation are the result of the interaction of the organization with the environment, making it a cultural, economic and social phenomenon (Ferreira et al., 2021; Kesavan, 2021; Manjarrés Henríquez & Vega Jurado, 2012).

Therefore, IM in organizations has also evolved, changing from the execution of processes such as evaluation, selection, planning, organization, and control of projects based on technology management, to the execution of the same processes, but now based on knowledge management and organizational capabilities (Hyland & Karlsson, 2021; Laperche, 2021; Magnier-Watanabe & Benton, 2017; Melendez et al., 2019; Musiolik et al., 2018; Rothwell, 1994; Santoro et al., 2020).

This means that IM in the business field can be considered as a problem of organized complexity in which human and social agents intervene, along with the application of a set of capabilities focused on improving the performance of companies (Bohórquez, 2016; Lepore et al., 2016).

To understand IM as a system, it is advisable to previously define a system model that contains its components and the relationships established between them (Falcone-Treviño et al., 2018; Melendez et al., 2019). Furthermore, considering Schumpeter's vision of innovation, all innovation must have a response in the profitability of the organization and in the participation of the innovated products in the market (Nakamori, 2020; Szczepańska-Woszczyna, 2021).

As such, this research takes as a reference the theoretical proposal of innovation management (IM) developed by Ibujés-Villacís & Franco-Crespo (2022) in which IM is presented as a multidimensional system made up of three main categories or constructs: knowledge management (KM), innovation capabilities (IC), and financial performance (FP), as shown in Figure 1.

The proposed IM model is composed of latent variables or constructs and observed variables, which were obtained through a study that used Grounded Theory as a research technique and utilizing different data sources such as questionnaires, interviews, and documentary research.

A construct in social sciences is an abstract and probably hypothetical entity that is inferred from a set of actions similar to each other, which can be demonstrated or observed directly, allowing us to understand the phenomena studied (Lune & Berg, 2017; Price, 2017). Constructs—also called unobservable or latent variables—do not have an operational method of direct measurement (Hair et al., 2019; Thakkar, 2020). For this reason, it is necessary to find some observed measures called reflective indicators, which are manifestations of the latent construct (Price, 2017; Wang & Wang, 2020).

This distribution of the categories and the relationships between them represents the proposal for innovation management in business organizations, whose theoretical approaches are summarized below.

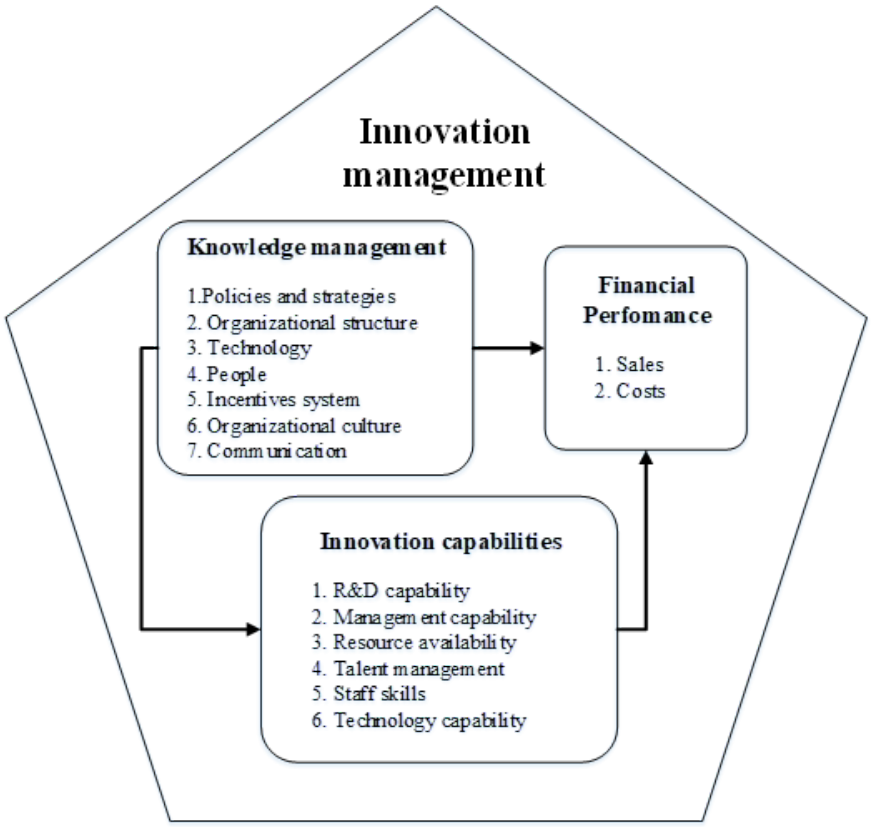

Figure 1. Diagram of innovation management.
Source: Obtained from Ibujés-Villacís & Franco-Crespo (2022) .

2.2 Knowledge management

In the field of organizational management, there is practically a consensus that at the current time, the most important strategic resource of organizations is knowledge (Bolisani & Bratianu, 2018; Davila et al., 2019; Kesavan, 2021; North & Kumta, 2018). As such, KM is one of the most important organizational capabilities of organizations to innovate products and processes (Camisón-Haba et al., 2019; Chang et al., 2017; Ode & Ayavoo, 2020).

KM is a multidimensional category that covers important aspects related to the human, technological, and political dimensions, which interact in the complex process of value creation in organizations (Espindola & Wright, 2021; Manning & Manning, 2020; Obeidat et al., 2016). Table 1 describes the subcategories of KM according to the reviewed literature and details the most relevant properties that explain KM in the manufacturing industry (Ibujés-Villacís & Franco-Crespo, 2022).

Table 1. Subcategories and properties of knowledge management.

Knowledge management – KM		
Subcategories	Authors	Specific properties
Policies and strategies (PS)	(Marulanda et al., 2016). (Medina Nogueira et al., 2019). (Husain & Ermine, 2021). (Abbas et al., 2019)	Planning Knowledge processes Public and private alliances Barriers Continuous improvement
Organizational structure (OS)	(Marulanda et al., 2016). (Chouikha, 2016). (Philipson, 2020)	Knowledge possession Internal structure Hierarchical levels Access to knowledge
Technology (TG)	(Chouikha, 2016). (Husain & Ermine, 2021). (Salmador et al., 2021). (Lähteenmäki & Töyli, 2023)	Technological management Information systems Corporate social networks
People (PP)	(Chouikha, 2016). (Medina Nogueira et al., 2019). (Sparrow, 2019). (Del Carpio Gallegos & Miralles, 2019).	Years of experience Education level Age Language Gender
Incentive systems (IS)	(Marulanda et al., 2016). (Chouikha, 2016). (Del Carpio Gallegos & Miralles, 2019).	Economical Training Days off Public recognition
Organizational culture (OC)	(Calvo, 2018). (Medina Nogueira et al., 2019). (Aramburu et al., 2015). (Marín-Idárraga & Cuartas-Marín, 2019).	Personal values Attitude towards work Respect for regulations Better practices Personal commitment Work environment
Communication (CM)	(Marulanda et al., 2016). (Husain & Ermine, 2021). (Abuaddous & Al Sokkar, 2018).	Formal Informal Hierarchical Physical and virtual spaces

Source: Adapted from Ibujés-Villacís & Franco-Crespo (2022).

2.3 Innovation capabilities

Joseph A. Schumpeter (1883-1950) understood innovation as the introduction of new products or the improvement of existing ones, the introduction of a new or improved production method, the opening of a new market, the use of a new sales or purchase method, the use of new raw materials or semi-finished products, or the introduction of new forms of production organization (Nakamori, 2020; Szczepańska-Woszczyna, 2021).

New capabilities are required to innovate organizations, which are related to skills to continuously transform and exploit the potential of organizational knowledge to create value through the generation of significant changes in products and processes (Kaur, 2019; Nakamori, 2020; OECD & Eurostat, 2018). With these capabilities, organizations develop new intra- and inter-organizational learning systems, and focus organizational management towards the market and changing environments (Bogodistov et al., 2017; Bykova & Jardon, 2018; Kodama, 2018; Salmador et al., 2021).

Table 2, according to the bibliographic review carried out, presents the subcategories of IC and the most relevant properties that explain IC in the manufacturing industry (Ibujés-Villacís & Franco-Crespo, 2022).

Table 2. Subcategories and properties of innovation capabilities.

Innovation capabilities – IC		
Subcategories	Authors	Specific properties
Research and Development (R&D) capability (RD)	(OECD & Eurostat, 2018). (Del Carpio Gallegos & Miralles, 2019). (Tello, 2017). (Bourke & Roper, 2017). (Robbins & Sandberg, 2023)	Innovation strategy Market studies Budget Internal and external barriers Alliances Trained staff
Management capability (MC)	(Salmador et al., 2021). (OECD & Eurostat, 2018). (Zawislak et al., 2018). (Di Vaio et al., 2021).	Dynamic and efficient business processes New markets continuous improvement Alliances in the value chain Political and economic environment
Resource availability (RA) RA	(Aramburu et al., 2015). (Del Carpio Gallegos & Miralles, 2019). (Tello, 2017). (Del Carpio Gallegos & Miralles, 2019). (Tello, 2017).	Machinery and equipment Capital for investment Technology Information Civil infrastructure Capital for investment Technology Information Civil infrastructure
Talent management (HT)	(OECD & Eurostat, 2018). (Marulanda et al., 2016). (Del Carpio Gallegos & Miralles, 2019). (Sparrow, 2019). (Marulanda et al., 2016). (Del Carpio Gallegos & Miralles, 2019). (Sparrow, 2019).	Staff capabilities Permanent training Performance evaluation Professional level assessment Permanent training Performance evaluation Professional level assessment

Innovation capabilities – IC		
Subcategories	Authors	Specific properties
Staff skills (SS)	(OECD & Eurostat, 2018). (Tello, 2017). (Del Carpio Gallegos & Miralles, 2019). (Tello, 2017). (Del Carpio Gallegos & Miralles, 2019).	Teamwork Attitude towards learning Ease of communication Share knowledge Alignment with business goals Attitude towards learning Ease of communication Share knowledge Alignment with business goals
Technological capability (TC)	(OECD & Eurostat, 2018). (Del Carpio Gallegos & Miralles, 2019). (Tello, 2017). (Salmador et al., 2021). (Graham & Moore, 2021) (Del Carpio Gallegos & Miralles, 2019). (Tello, 2017). (Salmador et al., 2021). (Graham & Moore, 2021)	Technology to innovate Technology for decision making Technology to interact with customers and suppliers Technology for decision making Technology to interact with customers and suppliers

Source: Adapted from Ibujés-Villacís & Franco-Crespo (2022).

2.4 Financial performance

The results of innovation in business organizations are generally reflected in financial results. In this sense, some contributions show, for example, that FP in companies is impacted by some KM factors that are strategic to create innovations, such as intellectual capital and technology (Abuaddous & Al Sokkar, 2018; Chen et al., 2018; Del Castillo Guardamino & Egoávil, 2021; Namdarian et al., 2020).

Additionally, it is pertinent for companies to evaluate business results concerning the development of capabilities and use of resources they allocate for innovation activities (Bykova & Jardon, 2018; OECD & Eurostat, 2018; Singh et al., 2020). Therefore, evaluating the effects of KM and the development of IC in FP is one of the constant concerns of business organizations (Bykova & Jardon, 2018; Chen et al., 2018; OECD & Eurostat, 2018; Singh et al., 2020; Zaim et al., 2019).

Table 3, according to the sources consulted, describes the most relevant subcategories and properties that explain FP in the manufacturing industry (Ibujés-Villacís & Franco-Crespo, 2022).

Table 3. Subcategories and properties of financial performance.

Financial performance		
Subcategories	Authors	Specific properties
Sales (SL)	(OECD & Eurostat, 2018). (Zaim et al., 2019). (Singh et al., 2020). (Abuaddous & Al Sokkar, 2018)	Sales increase New markets Market share Marketing channels Provider networks Brand reputation New businesses Customer satisfaction
Costs (CS)	(Zaim et al., 2019). (Bourke & Roper, 2017). (Marín-Idárraga & Cuartas-Marín, 2019)	Benefit / cost ratio Costs reduction Optimization of processes Quality increase Reduced delivery time Production efficiency

Source: Adapted from Ibujés-Villacís & Franco-Crespo (2022).

3 Statement of hypotheses

The systemic approach of IM is shown as a structural model in Figure 2. This model consists of three main constructs or categories with their respective subcategories that were described in tables 1, 2, and 3.

As mentioned previously, the objective of this research is to determine the relationship that exists between the main constructs or categories that constitute innovation management in the manufacturing industry of the province of Pichincha in Ecuador. To achieve this research objective, four hypotheses are proposed, as follows:

$\mathcal{H}_1$: There is a significant, positive, and direct relationship between knowledge management and financial performance.

$\mathcal{H}_2$: There is a significant, positive, and direct relationship between knowledge management and innovation capabilities.

$\mathcal{H}_3$: There is a significant, positive, and direct relationship between innovation capabilities and financial performance.

$\mathcal{H}_4$: Innovation capabilities positively and directly mediate the relationship between knowledge management and financial performance.

4 Methodology

This research has a quantitative approach. It is correlational, non-experimental, and transversal. Its purpose is to test a set of hypotheses related to latent constructs such as KM, IC and FP that form an innovation management model. These hypotheses are tested based on the quantification and significance of the correlations between the constructs, which are determined using three methods to guarantee reliability of the results.

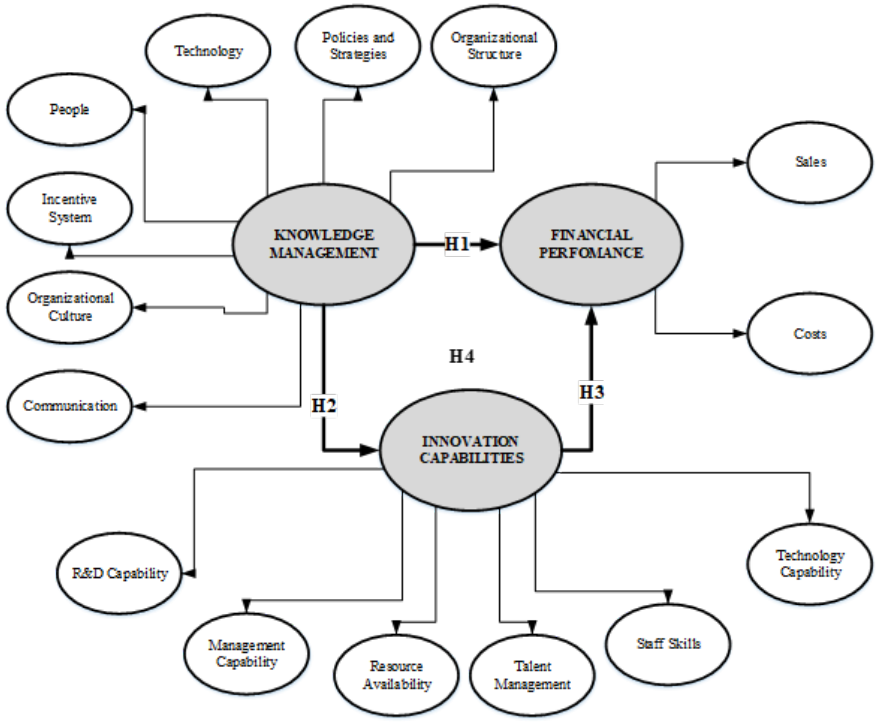

Figure 2. Structural model of innovation management.
Source: Made by the authors

4.1 Population and sample size

The scope of the study is the companies in the manufacturing economic sector of the province of Pichincha, which contains Quito, the capital of Ecuador. This economic sector was chosen because it contributes the most to the country's economy, with a contribution of 14.2% to Ecuador's total production (MIPRO, 2021). Considering the amount of investment, the last national innovation survey showed that this sector allocated 44.65% of total expenditure to innovation activities, becoming the economic sector that invested the most in research and development (SENESCYT-INEC, 2015).

The study population of this research is made up of medium-sized manufacturing companies in the province of Pichincha, companies that are active and have been in operation for at least five years. These companies have between 50 and 199 workers, annual income between 1 and 5 million dollars, and an asset value of less than 4 million dollars (SUPERCIAS, 2021).

Until November 2020, the medium-sized manufacturing companies in Pichincha that had presented their economic and financial reports for 2019 were 338 (SUPERCIAS, 2020). For the sample size calculation, this study uses proportional sampling for a finite population; Furthermore, the sampling was probabilistic and with equal probabilities. The selection of companies was carried out in a simple random manner, without replacement, in order to have the highest degree of representativeness of the sample (Latpate et al., 2021; Lohr, 2019).

To find a representative and adequate sample (n) of the population, equation 1 was applied (Lohr, 2019; Ott & Longnecker, 2016).

$$n = \frac{Z^2 N p q}{E^2 (N-1) + Z^2 p q} \tag{1}$$

The parameters for calculating the sample are as follows: $N = 338$ (study population), $E = 10$ % (sampling error percentage), $Z = 1{,}96$ (95% confidence level), $p = 0{,}5$ (probability of success), and $q = 0{,}5$ (probability of failure). With these parameters, it was determined that $n =$ 75 MEs.

4.2 Research technique and data

The applied research technique was a survey with close ended questions addressed to senior managers of the sampled companies. The developed questionnaire evaluated 85 propositions or items distributed in three main sections that represent the constructs: KM (35), IC (37), and FP (13). These items were obtained from each of the properties of the 15 subcategories described in tables 1, 2, and 3.

This questionnaire was subjected to content validation by experts, considering four categories: coherence, relevance, clarity, and sufficiency of the questions. Ten experts from academia and industry participated in the pilot test to guarantee these qualities. The pilot test was carried out before data collection on the entire sample.

Based on the validation and comments regarding the questionnaire, the suggested improvements were incorporated, and the final version is presented in Appendix 1. To respond to the questionnaire, company managers were asked to rate each of the items using the psychometric instrument known as the Likert scale (Bertram, 2018). A 10-point scale was employed, with 1 indicating very low agreement and 10 indicating very high agreement with the arguments presented in each of the items.

The surveys were conducted using Google Forms, applied electronically from June to September 2021. A total of 250 questionnaires were sent via email to the companies that were the subject of the study. Each survey complied with the ethical standards of research: informed consent, voluntary participation, confidentiality, and no exposure to physical or psychological risks to the participants.

4.3 Data analysis

After preparing the data and the initial model evaluations, we refined the assessed items. On one hand, we identified bivariate covariances greater than 0.85 among the items of each subcategory. This allowed us to eliminate items that measured very similar aspects, reducing data redundancy. On the other hand, we removed some items with factor loadings less than 0.5.

Considering these covariance criteria and factor loadings, we obtained 62 valid items from the 85 initially proposed. Some authors suggest that items showing in high covariance and low factor loadings in a confirmatory factor analysis should be excluded from the model analysis (Hair et al., 2019; Kline, 2016).

To evaluate the relationships between constructs and test the four hypotheses, We applied multivariate statistical analysis to determine the existence of a correlation with standardized values between pairwise constructs; i.e., H1: the correlation between KM and FP; H2: the correlation between KM and IC; H3: the correlation between IC and FP; and finally H4: the correlation between KM and FP mediated by IC, as shown in the structural model in Figure 2.

The correlation between the constructs was obtained using three methods with the help of R software version 4.1.1 (Thakkar, 2020).

- Method 1: Multiple correlation was applied, involving a linear combination of the items from each subcategory. Next, we determined the correlation between each of the subcategories of the constructs and finally the correlation between the constructs.

- Method 2: The canonical correlation was calculated understanding each construct as a group of subcategories with their respective observed variables (Trendafilov & Gallo, 2021).
- Method 3: Using structural equation modeling (SEM) based on covariance matrices, we simultaneously estimated multiple and interrelated dependency relationships between the constructs or latent variables that constitute the proposed theoretical innovation management model. Additionally, confirmatory factor analysis was applied to quantify the dependencies and correlations between the constructs, subcategories, and measurable variables to test the four hypotheses detailed above (Hair et al., 2019; Thakkar, 2020).

5 Results

In total, 142 valid responses were received out of 250 questionnaires that were sent. The number of responses exceeded the sample size estimated by the equation ($n = 75$), which reduced the sampling error to 6% and maintained the confidence level at 95%. Table 4 shows the number of companies surveyed and the type of activity they represent in the manufacturing sector.

Table 4. Economic activity of the surveyed companies.

Economic activity	Company	(%)
Manufacture of metal products	39	27
Manufacture of computer products, electronics and optics	23	16
Manufacture of chemical substances and products	14	10
Manufacture of machinery and equipment	13	9
Repair and installation of machinery and equipment	12	8
Manufacture of coke and petroleum refining products	8	6
Manufacture of electrical equipment	7	5
Manufacture of food products	4	3
Manufacture of textile products	4	3
Printing and reproduction of recorded media	3	2
Manufacture of rubber and plastic products	3	2
Manufacture of beverages	2	1
Manufacture of motor vehicles	2	1
Manufacture of other types of transport equipment	2	1
Manufacture of clothes	1	1
Manufacture of wood products	1	1
Manufacture of paper and paper products	1	1
Pharmaceutical manufacturing	1	1
Manufacture of other non-metallic mineral products	1	1
Furniture manufacturing	1	1
Total	142	100

Source: Made by the authors.

Among the positions of the directors who participated in the survey were administrative managers, technical managers, sales directors, marketing coordinators, purchasing directors,

project directors, planning directors, and others, with an average of three years of experience in their positions.

5.1 Descriptives of the constructs and subcategories

To obtain the basic descriptive statistics of the subcategories and the KM, IC, and FP constructs, the responses are added for each subcategory and then for each construct.

In Table 5, with average values as a reference, it is determined that organizational culture, policies and strategies, technology, and the form of communication between staff are highly significant in knowledge management. However, subcategories such as personnel characteristics and incentive systems are less significant. This situation highlights the need for companies to place substantial effort into improving personnel selection and implementing incentives to achieve a level of KM that enables innovation.

Table 5. Basic descriptive statistics of KM and subcategories.

Knowledge management - KM					
Subcategory	Mode	Med.	Avg.	SD	CV (%)
PS	7.9	7.2	6.7	2.3	34.5
OS	7.8	6.2	6	2.4	39.8
TG	7.8	7.2	6.7	2.4	35.2
PP	7.1	6.1	5.8	1.9	32.4
IS	1.2	3.4	3.8	3	77.7
OC	8.5	7.7	7.2	2.4	33.9
CM	7	6.8	6.5	2	30.4
KM	7	6.4	6.2	1.9	30.7

Notes: cases = 142; Med.: median; Avg.: Average; SD: standard deviation; CV: coefficient of variation.

Source: results obtained from R.

In the case of the IC construct, Table 6 identifies that the important subcategories in the development of innovation capabilities are technological capacity, staff skills, management capacity and talent management. The resource availability and research and development are less important. The lower significance of the last two subcategories demonstrates that companies have limited tangible and intangible resources for innovation development and engage in minimal research and development to create or modify processes and create new products.

Table 6. Basic descriptive statistics of IC and subcategories.

Innovation capabilities - IC					
Subcategory	Mode	Med.	Avg.	SD	CV (%)
RD	6.3	6	5.8	2.7	46.3
MC	7.1	6.4	6.1	2.6	41.9
RA	7.1	6.4	5.9	2.9	48.3
HT	7.2	6.4	6	2.7	44.6
SS	6.7	6.5	6.2	2.6	41.4
TC	7.8	6.9	6.5	2.5	38.6
IC	7	6.4	6.1	2.4	40.3

Notes: cases = 142; Med.: median; Avg.: Average; SD: standard deviation; CV: coefficient of variation.

Source: results obtained from R.

According to the results presented in Table 7, the subcategories that contribute the most to FP are sales. This indicates that it is a permanent concern for companies how to increase them, and other challenges such as the search for new markets, the reputation of the brand, and customer satisfaction. As costs are the least important subcategory, companies should optimize their costs, improve the quality of their products, and be more efficient to achieve adequate innovation management.

Table 7. Basic descriptive statistics of FP and subcategories.

Financial performance - FP					
Subcategory	Mode	Med.	Avg.	SD	CV (%)
SL	7.7	6.7	6.3	2.5	40.5
CS	7.9	6.4	6	2.7	44.9
FP	7.5	6.5	6.1	2.4	39.8

Notes: cases = 142; Med.: median; Avg.: Average; SD: standard deviation; CV: coefficient of variation.

Source: results obtained from R.

5.2 Hypothesis testing by multiple and canonical correlation

After examining the descriptive statistics, the results of the different correlations between the latent constructs were analyzed. These correlations were obtained using the Pearson correlation coefficient (r) and its level of significance (p). In the test of the first hypothesis (H1), KM and FP constructs are involved with each of their subcategories.

Table 8 shows the results of the correlations between KM and FP. It is observed that the subcategories that best correlate are organizational culture and communication with costs. Therefore, personal values, a positive attitude towards work, respect for principles and regulations, the use of best practices, employee empowerment, a synergistic work environment, and good formal and informal communication between all hierarchical levels, both in physical and virtual spaces, positively influence the increase in production efficiency, the increase in product quality, and the reduction of product delivery time to customers.

On the other hand, subcategories such as people and organizational structure have the lowest correlations with the FP subcategories. To change this situation and ensure that KM has a positive impact on the FP, it will be necessary for companies to give more importance to the levels of education and experience of their staff, hire staff who speak more than one language, and, at the same time, change to organizational structures that facilitate the flow of knowledge.

Table 8. Correlations between KM and FP and their subcategories.

FP	0.53	0.51	0.52	0.46	0.55	0.67	0.68	0.69
CS	0.53	0.52	0.5	0.44	0.55	0.68	0.69	0.69
SL	0.48	0.44	0.49	0.43	0.48	0.59	0.6	0.61
	PS	OS	TG	PP	IS	OC	CM	KM

Note: All values are significant $p < 0.05$.

Source: results obtained from R.

As a result of the multiple correlation between the KM and FP constructs, $r = 0.69$ ($p < 0.05$) is obtained. On the other hand, the result of the canonical correlation between the same constructs is $r = 0.73$ ($p < 0.05$). By both methods, the correlation is positive, moderate, and significant.

In the case of the second hypothesis (H2), the correlation between KM and IC with each of its subcategories is shown in Table 9. It is evident that all subcategories of KM have a positive and significant influence on the subcategories of IC.

It is determined that management capabilities, talent management, research and development capabilities, staff skills, technological capabilities, and the availability of resources influence positively and significantly the development of innovation capabilities. However, the people subcategory is the one that has the least influence, which means that experience, level of education, age, and the use of an additional language are important aspects to consider when strengthening innovation capabilities.

Table 9. Correlations between KM and IC and their subcategories.

IC	0.68	0.7	0.7	0.55	0.73	0.73	0.7	0.84
TC	0.68	0.69	0.76	0.54	0.67	0.68	0.65	0.81
SS	0.62	0.65	0.67	0.49	0.68	0.73	0.75	0.81
HT	0.63	0.66	0.64	0.5	0.7	0.7	0.68	0.79
RA	0.56	0.57	0.55	0.51	0.59	0.55	0.52	0.67
MC	0.67	0.67	0.66	0.52	0.67	0.71	0.66	0.8
RD	0.67	0.68	0.67	0.5	0.72	0.7	0.68	0.81
	PS	OS	TG	PP	IS	OC	CM	KM

Note: All values are significant $p < 0.05$.

Source: results obtained from R.

In this case, the multiple correlation between KM and IC shows a positive, high, and significant value for $r = 0.84$ ($p < 0.05$). On the other hand, the canonical correlation between these two constructs also has a high and significant value for $r = 0.88$ ($p < 0.05$).

In the case of the third hypothesis (H3), the IC and FP constructs with their subcategories are involved. The results are summarized in Table 10 and show that all IC subcategories positively and significantly influence the sales and costs subcategories. The subcategory that has the least influence is the availability of resources, which shows that companies need to increase capital to carry out innovations, access to updated information, use of new technologies, and increased availability of infrastructure to carry out innovations.

Table 10. Correlations between IC and FP and their subcategories.

FP	0.77	0.76	0.69	0.74	0.74	0.71	0.79
CS	0.74	0.73	0.64	0.72	0.75	0.68	0.77
SL	0.72	0.71	0.69	0.68	0.66	0.67	0.74
	RD	MC	RA	HT	SS	TC	IC

Note: All values are significant $p < 0.05$.

Source: results obtained from R.

The result of the multiple correlation between IC and FP is $r = 0.79$ ($p < 0.05$). While the result of the canonical correlation between the same constructs is $r = 0.80$ ($p < 0.05$). In both cases the correlation is positive, high, and significant.

In the case of hypothesis H4, the contribution given by the KM construct to the FP construct is evaluated indirectly through IC; To do this, the correlation between KM and IC is multiplied by the correlation between IC and FP (Collier, 2020; Hayes, 2018). The result of the multiple correlation is $r = 0.66$ ($p < 0.05$) with the first method and $r = 0.70$ ($p < 0.05$) when the canonical correlation is applied. In both cases, the correlation is positive, moderate, and significant.

5.3 Results by hypothesis by SEM

To estimate the correlations between the latent constructs that allow testing of the hypotheses, 142 valid surveys were used as a sample size, the number of which provides sufficient statistical power for data analysis in SEM. Samples between 100 and 150 are recommended when the model has five or fewer constructs, each with more than three items (observed variables) and with high loading factors (0.6 or more) (Hair et al., 2019; Thakkar, 2020). The proposed model of this study possesses these characteristics.

To test the one-dimensionality, reliability, and convergent validity of the subcategories of each construct, a confirmatory factor analysis was carried out. These tests were carried out by calculating the loading factors, Cronbach's alpha, and the average variance extracted (AVE) (Hair et al., 2019). The results of these tests for each of the valid items (62) are shown in Table 11, as can be seen, only the PP subcategory does not meet the requirements, however, this subcategory was maintained since the theoretical model reference of the IM considers relevant to this subcategory that is part of KM.

Table 11. Results of the analysis of one-dimensionality, reliability and convergent validity.

Construct	Subcategory	Item	Factor loading (≥ 0.5)	Cronbach's alpha (≥ 0.7)	AVE (≥ 0,5)
KM	PS		0.83	0.9	0.72
		PS1	0.95		
		PS2	0.92		
		PS5	0.82		
		PS6	0.76		
	OS		0.86	0.87	0.73
		OS2	0.84		
		OS3	0.96		
		OS4	0.75		
	TG		0.87	0.93	0.82
		TG1	0.93		
		TG2	0.92		
		TG3	0.86		
	PP		0.74	0.68	0.43
		PP1	0.61		
		PP2	0.75		
		PP4	0.59		
	IS		0.78	0.85	0.66
		IS1	0.78		
		IS2	0.88		
		IS4	0.77		
	OC		0.85	0.95	0.79
		OC2	0.96		
		OC3	0.86		
		OC4	0.88		
		OC5	0.87		
		OC6	0.91		
	CM		0.84	0.82	0.65
		CM1	0.61		
		CM3	0.84		
		CM4	0.94		
IC	RD		0.97	0.94	0.73
		RD1	0.85		
		RD2	0.86		
		RD3	0.81		
		RD4	0.86		
		RD5	0.86		
		RD6	0.9		
	MC		0.99	0.92	0.76
		MC1	0.91		
		MC2	0.88		

Construct	Subcategory	Item	Factor loading (≥ 0.5)	Cronbach's alpha (≥ 0.7)	AVE (≥ 0,5)
		MC4	0.89		
		MC6	0.79		
	RA		0.85	0.94	0.77
		RA1	0.91		
		RA2	0.84		
		RA3	0.94		
		RA4	0.88		
		RA5	0.83		
	HT		0.96	0.96	0.8
		HT1	0.82		
		HT2	0.9		
		HT4	0.87		
		HT5	0.95		
		HT6	0.92		
		HT7	0.9		
		HT8	0.89		
	SS		0.95	0.93	0.77
		SS1	0.88		
		SS2	0.9		
		SS4	0.81		
		SS5	0.91		
	TC		0.94	0.89	0.72
		TC1	0.86		
		TC2	0.85		
		TC3	0.83		
FP	SL		0.93	0.93	0.8
		SL2	0.81		
		SL5	0.96		
		SL6	0.92		
		SL7	0.87		
	CS		0.93	0.96	0.83
		CS2	0.82		
		CS3	0.92		
		CS4	0.9		
		CS5	0.96		
		CS6	0.96		

Note: Items with low factor loadings (< 0.5) have been removed.

Source: results obtained from R.

Next, applying confirmatory factor analysis, we simultaneously obtained the correlations between constructs and the dependency relationship between the predictor variables and the latent constructs. The results are shown in the measurement model detailed in Figure 3. The measurement model can be proposed as a second-order multidimensional structure of the reflective-

reflective type. Here, the second order is represented by the main constructs or categories: KM, IC, and FP, while the first order comprises the subcategories or dimensions of each of the constructs.

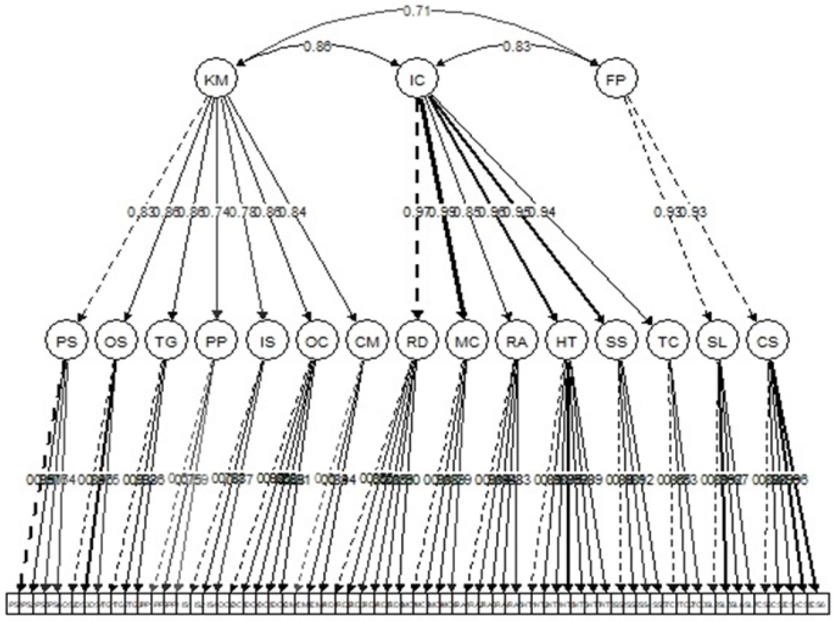

Figure 3. Innovation management measurement model.
Source: model developed by the authors in R software.

To ensure the suitability of the structural model, we computed the adjustment indices of the measurement model. Table 12 shows compliance through descriptive indices of absolute and relative goodness of fit applied in SEM (Thakkar, 2020).

Table 12. Adjustment indexes.

Type	Index	Current Value	Preferred Value	Conclusion
Absolute	Chi-square (χ^2)	3991.85	> 0.05	Good fit
	Relative/normalized chi-square (χ^2/df)	2.28	< 3	Good fit
	Root mean square error of approximation (RMSEA)	0.09	< 0.08	Acceptable
	Standardized residual mean square (SRMR)	0.07	< 0.05	Acceptable
Relative	Incremental fit (IFI)	0.8	> 0.9	Acceptable
	Comparative fit (CFI)	0.8	> 0.9	Acceptable

Source: results obtained from R.

Based on the goodness of fit indices, the results are deemed acceptable, even for those data points marginally fall below the reference values. This situation is justified on the basis that the sample is small (n = 142). (Thakkar, 2020; Wang & Wang, 2020). Consequently, the model is useful for testing relationships between constructs.

To verify the hypotheses, the results related to the correlations between the latent constructs were extracted from the measurement model, as depicted in Table 13, with the significance level of these correlations being below 0.05. To estimate the correlation between KM and FP mediated by IC, the value of the correlation between the KM and IC constructs and between IC and FP is multiplied.

Table 13. Correlations between latent constructs with SEM.

Latent constructs	r	p	Conf. Int. at 95%		Comment
			Lower	Higher	
KM ↔ FP	0.71	0	0.61	0.81	Significant
KM ↔ IC	0.86	0	0.81	0.91	Significant
IC ↔ FP	0.83	0	0.77	0.89	Significant
KM ↔ IC ↔ FP	0.71	0	0.62	0.81	Significant

Notes: r: correlation coefficient. p: significance level. Conf. Int.: Confidence interval.

Source: made by the authors.

The results of the correlation between KM and FP confirm H1. That is, there is a significant, positive, and direct relationship between knowledge management and the financial performance of medium-sized manufacturing companies.

Concerning hypothesis H2, the results show that there is a significant, positive, and direct relationship between knowledge management and the innovation capabilities of medium-sized manufacturing companies.

When synthesizing the results for hypothesis H3, it is determined that there is a significant, positive, and direct relationship between innovation capabilities and the financial performance of medium-sized manufacturing companies.

Considering the fourth hypothesis H4, it is confirmed that innovation capabilities positively and directly mediate the relationship between knowledge management and financial performance in medium-sized manufacturing companies.

6 Discussion

The results obtained are unprecedented in the Ecuadorian context, as there are no studies that focus on IM as a system made up of the relationship between KM, IC, and FP. As mentioned in the introduction, innovation management has been explained both in the theoretical field and in some empirical studies as a cause-effect relationship between certain organizational factors and innovation processes (Melendez et al., 2019).

In the LAC region, there is limited evidence of studies that analyze and evaluate innovation management as a system. Most of these studies have focused on measuring the degree of business innovation taking as reference the indicators of innovation manuals like the Oslo Manual (Álvarez et al., 2019; Rodríguez & Quintero, 2021).

There are also other research efforts, although not from the systemic approach, that have concluded that companies that invest in knowledge, optimize the use of new technologies, and develop the capabilities of their staff, are more capable of carrying out innovations (Aguilar-Barceló & Higuera-Cota, 2019; Bortagaray, 2016). In these circumstances, the analysis of the consistency

of the results was carried out with those studies that are closest to proposals for innovation management in the LAC region.

Hence, the confirmation of H1 is consistent with the findings of other previous studies. In prior research, KM factors such as knowledge exchange, intellectual capital and technology separately shape innovation strategies and cause an impact on financial performance (Abuaddous & Al Sokkar, 2018; Chen et al., 2018; Del Castillo Guardamino & Egoávil, 2021; Namdarian et al., 2020), and also in the productivity of companies (Pinochet, 2021; Torabi & El-Den, 2017).

The confirmation of H2 aligns with studies referring to the relationship between KM and IC in the business sector (Camisón-Haba et al., 2019; Chang et al., 2017; Di Vaio et al., 2021; Saqib et al., 2017; Sawatani, 2022), and the relationship that exists between the sources of knowledge and the types of innovation in the industry in countries in the LAC region (Claver-Cortés et al., 2018; Del Carpio & Miralles, 2020).

The confirmation of H3 aligns with the findings of previous studies, in which IM components such as R&D and organizational structure positively impact the financial performance of companies (Canh et al., 2019; Isfianadewi et al., 2019; Rajapathirana & Hui, 2018), particularly in the LAC region (Aramburu et al., 2015).

The confirmation of H4 aligns with the findings of previous studies on the mediating effect of innovation in the relationship between knowledge management and business performance around the world (Byukusenge & Munene, 2017; Hailekiros & Renyong, 2016), particularly in the LAC region (Davila et al., 2019).

The results of the positive and significant correlations found by the three methods not only confirm the four hypotheses related to the integration and systemic relationship between KM, IC, and FP, but also validate the constructs comprising the theoretical model of innovation management. This validity occurs when the latent variables are correlated and relate to the observed variables consistently, aligning with the predictions derived from the theoretical model used as a reference (Thakkar, 2020).

The contribution of this article lies in empirically confirming that innovation management is a complex system composed of three constructs that exhibit positive relationships, shedding new light on understanding the problem innovation scarcity in the Ecuadorian industry. Furthermore, the practical implication of the research is the ease of using the model and its relationships to obtain periodic measurements that would allow systematically evaluating the level of maturity of innovation management in the manufacturing industry.

7 Conclusions

This article aimed to determine the relationship that exists between KM, IC, and FP as relevant constructs or categories that shape an IM model for business organizations. To accomplish this objective, a set of hypotheses was formulated to investigate whether correlations exist between the constructs of the model. This verification process was executed through the application of multivariate statistical analysis.

To test the hypotheses, the data were obtained from a survey conducted among medium-sized manufacturing companies in the province of Pichincha in Ecuador. Correlations were calculated using three methods, and it was determined that there is a significant, positive, and direct relationship between knowledge management and financial performance, between knowledge management and innovation capabilities, and between innovation capabilities and financial performance. Furthermore, it was determined that innovation capabilities positively and directly mediate the relationship between knowledge management and financial performance.

On the other hand, the results of the evaluation of the IM model demonstrate that there is significant potential to increase the innovation of products and processes of manufacturing companies. To achieve this, companies need to improve: the educational level of staff, formal and informal communication between employees, cooperation and teamwork, staff incentives, employee commitment to the company's objectives, the amount of investment in R&D, efficiency in the use of its resources, the quality of its products and the awareness of business managers about the benefits offered by knowledge management and the development of innovation capabilities to increase financial performance.

Like any other research, this one has its limitations, with the most significant being the constraint on the participation of the respondents due to the negative effects of the COVID-19 pandemic. Although the number of respondents exceeded the theoretical sample size, financial resources and time were not available to access a larger number of respondents. This could have potentially yielded more precise results in the application of SEM and provided stronger support for the theoretical model.

With the objective of strengthening the field of study of innovation management and its impact on the growth of innovative companies, it is suggested to conduct research in other business contexts of the Ecuadorian economy. These contributions would allow, on the one hand, to expand the spectrum of study of the relevant factors that facilitate the management of innovation in the industry and encourage new companies to become innovative, and on the other hand, to better understand the problem of the lack of innovation and propose solutions from different actors and contexts of Ecuadorian society.

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9 Appendix 1: Survey Questionnaire.

Id.	Questions	Item
	Knowledge management	KM
	According to your knowledge and experience in the company, rate the degree of acceptance in which the following propositions positively influence the creation, acquisition, sharing and use of organizational knowledge.	
	Policies and strategies	PS
1	There are policies to acquire or generate organizational knowledge.	PS1
2	There are policies for storing, sharing, and using organizational knowledge.	PS2
3	Duly documented processes, procedures and routines are used.	PS3
4	Alliances are made with public or private organizations.	PS4
5	Dynamic plans are executed to face internal and external barriers.	PS5
6	There is a permanent focus on continuous improvement.	PS6
7	Old knowledge is systematically combined with new.	PS7
	Organizational structure	OS
8	There are units in the company dedicated to the research and development of new products and processes.	OS1
9	The access and use of organizational knowledge is regulated.	OS2
10	The processes for accessing organizational knowledge are agile.	OS3
11	The structure of the company facilitates the flow of knowledge horizontally.	OS4
12	The structure of the company facilitates the flow of knowledge vertically.	OS5
	Technology	TG
13	Technology is used to methodically store organizational knowledge.	TG1

Id.	Questions	Item
14	Information systems are used to access, share, and use organizational knowledge.	TG2
15	The information and communication technologies that they have contribute to the access, exchange, and use of knowledge.	TG3
16	Corporate social networks are used to collaborate and use the knowledge of the environment.	TG4
	People	PP
17	The years of experience of the employees is important.	PP1
18	The educational level of the employees is important.	PP2
19	The age of the employees is important.	PP3
20	Mastering a foreign language is transcendent.	PP4
21	The gender of the employees is important.	PP5
	Incentive systems	IS
22	Economic incentives are given for generating, sharing, and using knowledge.	IS1
23	Extraordinary trainings are provided as an incentive to generate, share, and use knowledge.	IS2
24	Free days are given as an incentive for generating, sharing, and using knowledge.	IS3
25	A public recognition is made as an incentive to generate, share, and use knowledge.	IS4
	Organizational culture	OC
26	Personal values are given importance.	OC1
27	A positive attitude towards work is encouraged.	OC2
28	Respect for the company's principles and regulations is promoted.	OC3
29	The use of best practices is cultivated.	OC4
30	Employees are empowered with the knowledge necessary for decision making.	OC5
31	A collaborative and synergistic work environment is fostered.	OC6
	Communication	CM
32	There is formal communication at work.	CM1
33	There is informal communication at work.	CM2
34	There is good communication with all hierarchical levels.	CM3
35	There is good communication in physical and virtual spaces.	CM4
	Innovation capabilities	IC
	According to your knowledge and experience in the company, rate the degree of acceptance in which the following propositions positively influence innovation capabilities.	
	Research and development capacity	RD
36	Research and development of new products and processes is carried out.	RD1

Id.	Questions	Item
37	Strategies such as creativity, teamwork, industrial property, or entrepreneurial spirit are applied.	RD2
38	Customer input is recognized as critical to innovations.	RD3
39	Market studies are carried out periodically to innovate.	RD4
40	Economic resources for research and development are budgeted.	RD5
41	It is planned to overcome the internal and external barriers that prevent research and development.	RD6
42	There is a relationship with universities, business associations, government, etc. to make innovations.	RD7
	Management capacity	MC
43	Dynamic and efficient business processes focused on innovation are available.	MC1
44	You have business skills to create or modify products and processes.	MC2
45	New markets for the products are constantly being sought.	MC3
46	New innovations are constantly monitored in the environment.	MC4
47	Customer satisfaction is measured periodically.	MC5
48	Best practices related to innovations are documented.	MC6
49	There is a relationship with public and private institutions to strengthen the value chain.	MC7
50	The company quickly adapts to the political and economic environment.	MC8
	Resource availability	RA
51	There is availability of machinery and equipment to carry out innovations.	RA1
52	There is availability of capital for investment in innovations.	RA2
53	There is access to new technologies to innovate products and processes	RA3
54	There is access to updated information to make innovations.	RA4
55	There is availability of civil infrastructure to carry out innovations.	RA5
	Human talent management system	HT
56	The professional capacity of the staff contributes substantially to the innovations.	HT1
57	The staff is aligned with policies and strategies focused on innovation.	HT2
58	The knowledge and experience of the staff contribute to innovation.	HT3
59	Workers are regularly trained to innovate.	HT4
60	The staff is committed to innovation activities.	HT5
61	The staff is motivated to participate in innovation activities.	HT6
62	Performance evaluation contributes to improving the human talent that contributes to innovate.	HT7
63	The professional contribution of the personnel dedicated to innovation is valued	HT8
	Staff skills	SS

Id.	Questions	Item
64	Teamwork is promoted as an innovation strategy.	SS1
65	There is a proactive attitude towards research and learning.	SS2
66	There is ease of communication between workers.	SS3
67	Knowledge is systematically shared among workers.	SS4
68	Employees get more creative and innovative.	SS5
	Technological capabilities	TC
69	Technology is used to develop new products and processes.	TC1
70	Technology is used to permanently capture, store, organize and share relevant information.	TC2
71	It relies on technology for decision making.	TC3
72	Information systems are used to interact with customers and suppliers.	TC4
	Financial performance	FP
	According to your knowledge and experience in the company, rate the degree of acceptance in which the following actions have a positive influence on corporate performance, taking the last twelve months as a reference.	
	Sales	SL
73	Sales have increased.	SL1
74	The products have new markets.	SL2
75	Marketing channels have increased.	SL3
76	Provider networks have increased.	SL4
77	The reputation of the brand has increased.	SL5
78	Business opportunities have increased.	SL6
79	Customer satisfaction has increased.	SL7
	Costs	CS
80	Production and marketing costs have been significantly reduced.	CS1
81	The ways of working in the company have improved significantly.	CS2
82	The increase in the quality of the products has increased significantly.	CS3
83	The delivery time of products to customers has decreased.	CS4
84	The benefit/cost ratio has increased.	CS5
85	Efficiency in production or marketing has increased.	CS6

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