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The Effect of the Knowledge Management Processes Capability on Innovation Activities in the Mexican Industry

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Abstract: Mexican industrial organizations focus their efforts on the development of new products and processes, including breakthrough technology. Few studies have focused on the analysis of this corporate effort. After an in-depth theoretical review, it has been detected that most of the research has been based on the study of knowledge management along its dimensions, and there has been no research that incorporates the capabilities of the knowledge management process and its effect on two activities that generate innovation. With the application of a Likert scale-type instrument to 279 industrial companies in Mexico, it was detected that there is a relationship and influence between the dimensions of knowledge acquisition (KAC), knowledge updating (KUP), knowledge protection (KP), knowledge conversion (KC) and knowledge application (KAP) in innovation-generating activities, such as research and development (R&D) and technology acquisition (TA). This was analyzed by the partial least squares (PLS) structural equation technique. Finally, it is important to highlight the contribution that the results of the study have in possible future research that can be carried out, for example, the analysis of the protection of knowledge and its impact on the industry of other countries.

Keywords: capabilities; industry; knowledge; innovation

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1. Introduction

There is currently a trend in organizations in the search for greater competitiveness, and this is related to the integration of a series of values, processes and behaviors developed through the use of the knowledge available and within their reach (Di Vaio et al. 2020); this is directly influencing organizational development and its respective ability to innovate (Ganguly et al. 2019). Knowledge can be defined as the domain or problematic in the understanding that one or a set of people have with respect to a relationship or situation, a causal phenomenon, one or several theories or rules, etc. (Qandah et al. 2020). There are two types of knowledge, explicit and tacit (Qandah et al. 2020). Meanwhile, both the resources and the capabilities derived from the knowledge of the people who are part of a company represent the foundations for its respective competitive business development (Shahzad et al. 2020).

Those organizations that show a greater capacity to manage knowledge are more likely to increase their competitiveness through the collection, organization and transformation of knowledge into specific productive activities (Bashir and Farooq 2019). This process is known as knowledge management (KM) (Asiedu et al. 2020) and plays an important role in influencing both employee performance and corporate values, representing an intangible resource in its own right (Duan et al. 2020).

KM organizes the collaboration of the members of a company to achieve greater productive effectiveness (Guerrero et al. 2019), thereby, becoming not only an intangible

resource but also a competitive advantage (Castaneda and Cuellar 2020; Nazam et al. 2020). It identifies, classifies and transfers knowledge (Qandah et al. 2020) and is able to position the resources and capabilities derived from it in production practices to obtain greater efficiency, even innovating processes, products and/or services (Duan et al. 2020).

Since the industrial revolution, innovation has represented a key to obtaining a competitive advantage, which has been highly influenced by environmental and contextual elements, as well as social dynamics and the level of national development surrounding each organization (Ernawati and Hamid 2020; Oliva et al. 2019; Obradović et al. 2021); nevertheless, it was not until the 1990s that interest in its study emerged (Podmetina et al. 2018). It is widely used by academics and practitioners to refer to new management processes in decision-making or the manufacture of products and/or services adapted from existing ones (Chen et al. 2019).

Innovation is also understood as an essential mechanism to strengthen competitiveness that benefits the growth and/or long-term survival of an organization (Durana et al. 2020). It is considered a practice or series of practices that allow for transforming the extracted knowledge of its members into useful capabilities for the company (Paoloni et al. 2020). Therefore, innovation depends on the availability of knowledge and its organizational capacity to identify and operate it (Du Plessis 2007).

For this reason, knowledge and KM are considered as the prerequisite (Qandah et al. 2020), foundation (Shahzad et al. 2020), or code (Asiedu et al. 2020) for the development and performance of innovation, positioning it as the responsible and central component for innovation rather than technology or finance (Goh 2005).

It is understood that innovation plays a highly influential role in the economic development of both companies and nations, which manages to enhance their capacity to innovate (Sharma 2019), but it has become an extremely complex process due to changing customer needs, extensive and competitive pressure from contemporaries and rapid technological change (Du Plessis 2007). However, the background positions KM as responsible for compiling and sharing the knowledge necessary for innovation (Ernawati and Hamid 2020), which is elemental to the creation of organizational value (Ganguly et al. 2019).

Consequently, when small manufacturing companies are seeking greater competitiveness, the exchange and management of knowledge in relationships and interactions with customers, suppliers and workers can produce innovation, but it must be protected as intellectual property rights as an organizational priority (Maldonado-Guzmán et al. 2016). As for large companies, not only to explore and operate new technologies, products, or services, but also to be willing to carry out the organizational changes derived from corporate governance, is necessary to achieve innovation (Steiber et al. 2020).

According to Hou et al. (2019), governments of economies in the European Union, China and even North America are seeking to stimulate innovation ecosystems, where their organizations behave as a heterogeneous constellation that co-evolves their capabilities in a value co-creation that fosters regional rather than individual development, that is, based on collective knowledge. The different cultural and social contexts of industrial clusters play a role in the pattern and style of networking interactions (Zhao et al. 2010), identifiable through KM. For this reason, KM is considered essential in the formation of human capital to achieve innovation in companies (Goh 2005) and seems to be a way to contribute to the development of an emerging Latin American economy (Gutierrez-Aristizabal and Ruiz-Arenas 2019).

Employees have a diverse repertoire of necessary knowledge and skills for the proper functioning of a company. They can recognize and assimilate information from different segments, with whom they daily interact, in a flow both internal and external to the company and form new combinations of knowledge to innovate (Martinez-Sanchez et al. 2020; Papa et al. 2018; Santos-Vijande et al. 2021; Pohlisch 2020).

KM manages, shares and protects the knowledge of the company's members and stimulates their capabilities and behaviors to achieve greater organizational effectiveness (Barros et al. 2020). Therefore, KM is of utmost importance in business management crises,

because it manifests itself as an organizational activity that links daily practices with the organizational mission, strategies and objectives (Wang 2009), as a result of the knowledge operation of its members (Santoro et al. 2021).

According to Shahzad et al. (2020), the KM process enables companies to respond to changes and improve sustainability and competitiveness operations, helping the organization to obtain what is required to develop innovation. That is, effective KM will drive collaboration among employees to innovate; however, KM by itself does not promote collaboration; rather, it is an activity that depends on creating a shared context among participants (An et al. 2014) that fosters their commitment to innovation (Huang and Li 2009; Ernst et al. 2014).

Similarly, innovation can be incremental or radical. The latter has a greater effect on the long-term success of companies and the development of markets and industries, but it also means high risk (Ritala et al. 2018); hence, it requires both attention and planned investment on the part of the company (Bokovets et al. 2020).

At the national level and according to data recorded by the National Institute of Statistics and Geography (INEGI 2016), more than 25% of SMEs in Mexico are innovative. That is why, out of 130 world economies, Mexico is positioned in 58th place as one of those that have most used innovation as a tool to improve its economy and its environment (Armenta 2017). Industrial activity in Mexico (mining; generation, transmission and distribution of electric power, water and gas supplies through pipelines to the final consumer; construction; and the manufacturing industries) grew by 0.9% during December 2017 (INEGI 2018). The industrial sector is a fundamental piece in the economic development of our country, to the point that, with the latest figures revealed by INEGI, as of the third quarter of 2017, the manufacturing industry as a whole represented 16% of the gross domestic product (Nagore 2018).

In this sense, organizations in the industrial sector in Mexico focus their efforts on developing value in their intellectual property through internally generated capabilities, with the main objective of creating competitive advantages through innovation (González et al. 2017). For this reason, the sector has been studied from different perspectives: in relation to the performance that industrial companies generate through innovation (Estrada et al. 2015; Jiménez and Valle 2006; and González et al. 2017) and from the perspective of using the generation of new knowledge to foster innovation (Jarvenpaa and Välikangas 2014; Dos Santos et al. 2014; Eseryel 2014; Moos et al. 2013; Arias-Pérez 2012; López et al. 2012).

Taking into consideration the different views of innovation, Freeman (1982) mentions that the lack of innovation causes organizations to cease to exist or operate since it is considered one of the fundamental keys to survival and the achievement of competitive advantages in today's business world. From Drucker's perspective (Drucker 1985), innovation is the means by which organizations led by innovative entrepreneurs detect an opportunity to grow their businesses through the process of improvement and differentiation. Nevertheless, from Schumpeter's (1935) economic point of view, innovative development is based on the introduction of new markets by making the economy maintain a constant economic struggle between goods and services. As a result, in 2005, the Organization for Economic Cooperation and Development (OECD 2007), in the Oslo Manual, stated that an innovation is the introduction of a new or significantly improved product (good or service), a process, or a new marketing or organizational method.

On the other hand, the origin of the study of knowledge goes back to ancient philosophy, where individuals such as Socrates, Plato and Aristotle stand out, whose bases were knowledge, self-reflection and knowledge of the self (Hessen and Silva Rincón 1994). In this sense, the study of knowledge has generated divisions for its comprehension; Dueck (2001) comments that there are four types of established knowledge: episteme, focused on principles and laws; techne, considered as technical knowledge; phronesis, as wisdom; and metis, known as aptitudes and competencies. Moreover, it should be noted that various concepts of knowledge management (KM) have emerged within organizations. The

reference on which their ideas are based is Nonaka and Takeuchi (1995), who see KM as the process of the internalization and externalization of the individual, while, for Aguirre and Tejedor (1998), Andreu and Sieber (1998), and Huang et al. (1999), it is a process to generate value and obtain competitive advantages by reusing already acquired knowledge. In a different case, Bueno (1999) mentions that KM is the function that plans and controls all the knowledge flows of the organization and its environment.

Based on the classification of elements that generate the knowledge management process, established by several theorists such as: (Holzner 1979; Pentland 1995; Nonaka et al. 1995; Demarest 1997; Daal 1998; Davenport 1998; and Liebowitz 1999 cited by (Hsieh 2007)), it has been concluded that there are five broad dimensions of the knowledge management process capability (KMPC): knowledge acquisition (KAC), knowledge updating (KUP), knowledge protection (KP), knowledge conversion (KC), and knowledge application (KAP) (Gold et al. 2001; Park 2006 cited by (Hsieh 2007)).

Taking into consideration the efforts made for the previous dimensions, there is an interest in identifying the efforts of competencies and capabilities that are known as innovation activities. According to Lugones (2013), these are scientific, technological, organizational, financial and commercial activities with the intention of implementing a new product or process, and/or a new marketing method, so it is appreciated that these efforts generate new knowledge, such as those of acquiring, adapting or developing existing knowledge. In this sense, research and development (R&D) and technology acquisition (TA) stand out.

Therefore, it would be interesting to analyze the capacity of the knowledge management process as a generator of innovation activities, highlighting the different ways of increasing productive and technological capabilities within organizations, for which the following research model is proposed (see Figure 1).

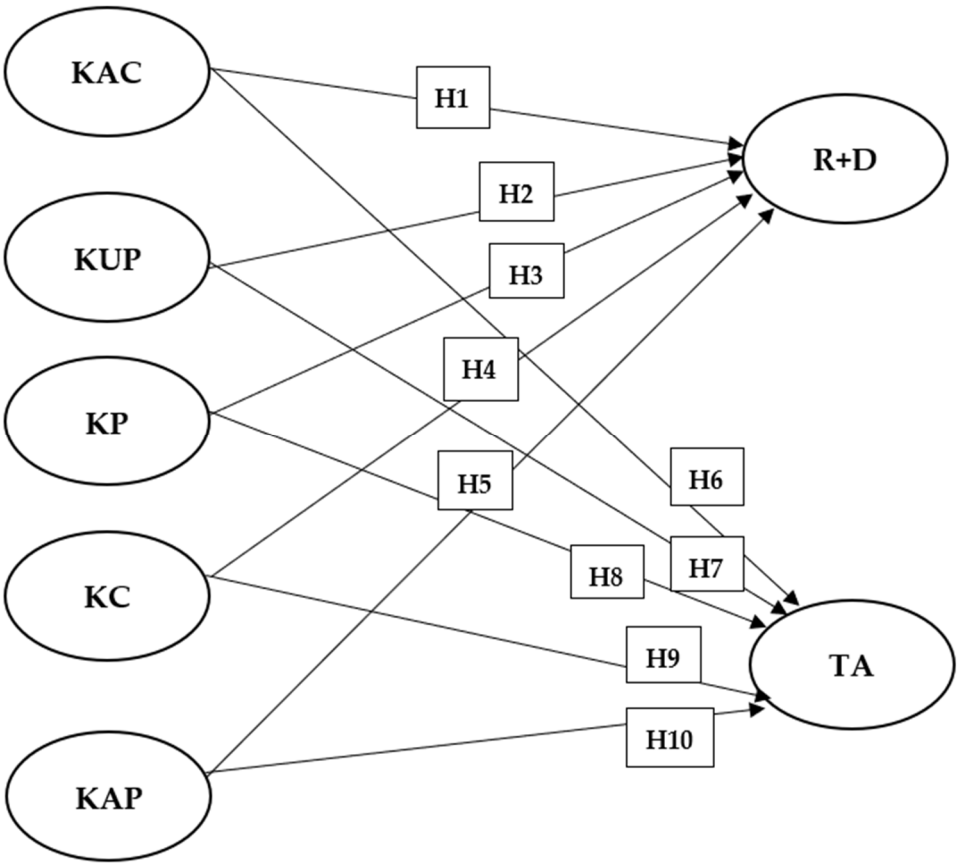

Figure 1. Proposed Research Model. Note: own elaboration.

It should be noted that any company in a developing country that includes an innovation process to increase knowledge attached to intellectual capital obtains direct benefits in product improvement and increased sales. In this way, organizations have a clearer and more effective vision of knowledge management in order to achieve an accurate understanding of the human and organizational processes through which information is transformed into discernment, knowledge and action for improvement in the organization (Aboites and Soria 1999; and García 2006). In this sense, it is proposed to conduct a study of the phenomenon experienced by industrial organizations in relation to the way they generate knowledge and their capacity for innovation through the following question: What is the relationship between the knowledge management process capability and the innovation activities carried out by SMEs in the Municipality of Cajeme?

2. Theoretical Review and Hypotheses

There are theoretical and scientific approaches regarding the relationship of the KMPC dimensions with innovation activities. The acquisition of knowledge through social capital is used to generate R&D (Laursen et al. 2011). The creation of new knowledge as the development of new products that position countries, based on the opinion of leaders in different strategic communities, is the view of Siachou et al. (2021) and Kodama (2003). Similarly, in the service industry, the analysis of absorptive capacity is established as strategies that allow external knowledge to be recognized, imported, integrated and developed within the organization effectively (Preece 2015); and, lastly, the impact of knowledge acquisition is based on the generation of strategies in firms where their employees are involved in innovation activities, particularly in R&D (Wang et al. 2020; Wang et al. 2019), where it is stated that:

H1. *Knowledge acquisition positively and significantly influences research and development.*

Despite the industry sector's emphasis on knowledge management, due to the emergence of academic projects among multiple universities and the university–industry linkage, initiatives should consider both parties' perspectives on knowledge gaps in organizations (Amoozad Mahdiraji et al. 2021) and assign increasing importance to knowledge and the complementary advantages of R&D, especially for industries with a fast updating of knowledge (Su et al. 2018). Since the environment of organizations is constantly changing, knowledge is perceived as a resource that should not stagnate but should be continually rethought (updated), especially in knowledge-intensive industries, such as high-tech industries. This is accomplished by investing in R&D (Studdard and Munchus 2009). On the other hand, knowledge among employees requires continuous development and acquisition/complementation of new information corresponding to their daily functions (Gope et al. 2018). Building and maintaining a viable innovation environment requires promoting knowledge transfer, but, at the same time, knowledge and innovations also need to be protected against imitations in order to maintain the benefits of outperforming rivals. The mechanism of protecting innovations resulting from acquired and protected/maintained knowledge, and the potential profit they can generate, increase the R&D of the organization and are focused on maximizing profit (Hurmelinna-Laukkanen 2011), in addition to the proposal of generating strategies such as influencing knowledge protection in R&D collaborations. (Bogers 2011), in which is stated the following:

H2. *The updating of knowledge has a positive and significant influence on research and development.*

H3. *Knowledge protection has a positive and significant impact on research and development.*

Based on a study of knowledge transfer in more than 15 industries, across three forms of government and between national and international R&D partners, it was found that the success of knowledge transfer is associated with several key variables and depends on both the R&D and understanding of the units where the desired knowledge resides within the source, the extent to which the parties share similar knowledge bases, and the extent of interactions between the source and the recipient to transfer the knowledge

and engage in an articulation process whereby the source's knowledge is accessible to the recipient (Cummings and Teng 2003). The study highlights the identification of a significant difference between the efficiencies of high- and low-performing R&D active companies in terms of the dimensions of knowledge management. (Mete and Belgin 2021). Meanwhile, considering the potential benefits resulting from collaboration and the importance of knowledge transfer, it is appropriate that some academic studies have focused on identifying and analyzing the conditions that enable and facilitate such conversion (Majuri 2022). In an industrial environment, knowledge generation enables organizations to collect, share and use knowledge systematically through internal development departments (Amoozad Mahdiraji et al. 2021) to increase industry performance; hence, it is necessary to identify knowledge conversion as a key to development and innovation. (Kinyua et al. 2015). The above generates the following:

H4. *Knowledge conversion positively and significantly influences research and development.*

There are studies that reveal the types of acquired knowledge and how it is transferred and learned for the development of countries (Zou and Ghauri 2008). In Japanese companies, this intra-firm knowledge transfer is a key source of competitive advantage for multinational companies (Kim et al. 2022). In other sectors, knowledge sharing is studied as an influence on R&D decisions and how knowledge management relies on a risk assessment that is handled directly by R&D (Ahokangas et al. 2021; Legros and Galia 2011). In the process of the internationalization of companies, inter-organizational knowledge transfer is particularly important for value creation and the development of competitive advantages (Del Giudice et al. 2017; Sukumar et al. 2020 cited by (Amoozad Mahdiraji et al. 2021)). The above supports the following:

H5. *The application of knowledge positively and significantly influences research and development.*

Regarding the support of the hypotheses related to technology acquisition, there are studies in which the moderating effect of knowledge acquisition on innovation elements, such as technological adequacy and innovative performance, is detected (Jiang et al. 2022; Li and Gao 2021). In addition, the influence of knowledge acquisition on innovative performance in technology-acquiring firms is highlighted (Vick et al. 2013; Bojica and Fuentes 2012). On the other hand, knowledge acquisition is appreciated for the technology approach as a financial risk support (Xia et al. 2022). Finally, the ability to acquire knowledge is to recognize how much the information is worth, assimilate it and apply it to improve routines and processes, innovating various sources of technology (Wang et al. 2020).

H6. *Knowledge acquisition positively and significantly influences technology acquisition.*

There is extensive research about information management, based on its updating and protection for the creation of knowledge in companies with a technological acquisition base (Jonas and Laios 1993). Given that the organizational environment is constantly changing, knowledge is perceived as a resource that should not stagnate but should be continuously updated, especially in knowledge-intensive industries such as high technology. The updating of knowledge is complex and requires developing, acquiring and operating knowledge in shorter periods of time than normal, which is why the support of the use of technologies can be appreciated and has an effective impact on the satisfaction of employees using this new technology (Studdard and Munchus 2009). It is necessary to point out the appropriability of technological innovations and the attributes of technological knowledge: codifiability, teachability, complexity, observability and dependence, and how these can influence the decisions that companies make between different protection mechanisms such as: patents, secrecy, delivery times, learning curves and complementary resources (Nieto and Pérez-Cano 2004). On the other hand, it is necessary to analyze the influence of knowledge on technology acquisition based on the use of networks (Yan and Li 2022; Malhotra et al. 2021), and how technology acquisition leads to adequate knowledge sharing and knowledge updating. (Tiwari 2022). Therefore, this supports the following:

H7. *The updating of knowledge has a positive and significant influence on the acquisition of technology.*

H8. *Knowledge protection has a positive and significant influence on technology acquisition.*

In the same way, it is conducive to study the relationship of knowledge conversion, its transfer and application through knowledge sharing within organizations through the implementation of digital platforms (Arfi and Hikkerova 2019). Technological knowledge arises from and is embedded in human activity; in contrast to scientific knowledge; the intellect is at the heart of the technological process, and the process itself consists of the acquisition and application of a body of knowledge about techniques, i.e., the ways of doing things (Herschbach 1995). Furthermore, there are studies that observe the feasibility of joint actions with technology companies that favor the creation and conversion of knowledge, generating intellectual capital and innovation capacity. (Obeidat 2019; Caldas and Ataide Candido 2013). Applications concerning knowledge technology in the industry are the current trend in the field of construction. There are currently demands that, despite what is being done, are not satisfying what is generally required in the field of information and communication technologies. Digitization in the construction industry is key in the implementation of progressive knowledge-based technology, which is why there are studies that focus on analyzing knowledge technology and its application in the industry (Mesaros et al. 2018), which supports:

H9. *Knowledge conversion positively and significantly influences technology acquisition.*

H10. *The application of knowledge positively and significantly influences the acquisition of technology.*

The main purpose of the above is to explain the relationship and influence of the capacity of the knowledge management process (KMPC) as a mechanism for generating innovation activities in the industrial sector of Cajeme, Mexico for the generation of models and contributions that explain the reality of this type of organization.

3. Materials and Methods

In order to develop and fulfill the objective of this research, an instrument was applied to 279 companies that are part of the industrial sector in Cajeme, Mexico. The information obtained included demographic data such as sector, line of business, age, gender and seniority. The most influential sector was the private sector, with a participation of 99.5%, where the majority of respondents were male, with 56% participation. The years of service of the employees who participated ranged from 1 to 45 years and more, where most of the participants had 45 years of service or more (44%). In order to obtain quantitative data, a measurement instrument was generated, consisting of 25 items, divided into two sections. The first section focuses on the five capabilities of the knowledge management process, adapted from those proposed by Hsieh (2007), and consists of 15 items. The second section of the instrument comprises the two innovation activities: the first activity is research and development (R&D), which is composed of six reagents and is based on the authors Moyeda Mendoza and Arteaga García (2016), and Koller (2014); followed by the activity of acquisition of technology (AT) with four items, where the basis is the proposal of Lugones (2013), Bianchi (2001), Anlló et al. (2014) and Antolín-López et al. (2016).

To test the hypotheses, the partial least squares (PLS) structural equation technique was used. The Smart PLS V. 4 software was used to evaluate the research model.

4. Results

The obtained results are presented, considering first the reliability by internal consistency for the identification of the Cronbach's alpha coefficient and the composite reliability coefficients. Subsequently, the evaluation of the questionnaire indicators is presented to verify that the used items are capable of measuring each of the analyzed variables in the research model. Additionally, the average variance extracted (AVE) is shown as the measure to which each of the items correctly integrates the variable to which they conform.

4.1. Internal Consistency Reliability

Table 1 presents the results of Cronbach's alpha coefficient, as well as that of composite reliability. As can be seen, almost all the constructs present indicators greater than 0.70, which represents an acceptable level of reliability of the items when constructing a variable. There is only the case of the UP (updating) variable that obtained a Cronbach's alpha of 0.65, although the indicators corresponding to the composite reliability in the same variable present indices higher than 0.70, which is considered acceptable (Hair et al. 2017).

Table 1. Internal consistency reliability.

	Cronbach's Alpha	Composite Reliability (rho_a)	Composite Reliability (rho_c)
UP	0.65	0.71	0.85
AC	0.90	0.90	0.95
AT	0.89	0.89	0.92
AP	0.81	0.83	0.89
C	0.88	0.89	0.92
R&D	0.94	0.94	0.95
P	0.94	0.94	0.95

Note: Source: own elaboration with Smart-PLS V 4 data.

4.2. Evaluation of Indicators

Table 2 presents the analysis of the evaluation of each of the included items in the questionnaire so that it can be confirmed that each of them loads on their respective constructs values greater than 0.50, which is considered an acceptable range for the research (Hair et al. 2017). In fact, most of the items present scores higher than 0.80, which implies a conformation of the variables that is considered good in its measurement.

Table 2. Evaluation of indicators.

	UP	AC	TA	AP	C	R&D	P
UP1	0.91						
UP3	0.80						
AC1		0.96					
AC2		0.95					
AP4				0.74			
AP6				0.91			
AP7				0.90			
C1					0.86		
C2					0.87		
C3					0.85		
C4					0.85		
P1							0.87
P2							0.92
P3							0.95
P4							0.92
TA1			0.77				
TA4			0.90				
TA5			0.90				
TA6			0.90				
R&D1						0.84	
R&D2						0.86	
R&D3						0.93	
R&D4						0.92	
R&D5						0.87	
R&D6						0.82	

Note: Source: own elaboration with Smart-PLS V 4 data.

4.3. Convergent Validity

Table 3 shows the average variance extracted (AVE) scores, which is a quality indicator related to the way in which the variables conform to each of the items used in the questionnaire. As can be observed, the values for the AVE are greater than 0.50, which implies that they are acceptable for the model proposed in the research (Hair et al. 2017).

Table 3. Convergent validity.

	Average Variance Extracted (AVE)
UP	0.73
AC	0.91
TA	0.75
AP	0.73
C	0.73
R&D	0.77
P	0.84

Note: Source: own elaboration with Smart-PLS V 4 data.

4.4. Discriminant Validity: Heterotrait-Monotrait Ratio (HTMT)

Another of the necessary tests to conclude that the measurement model used is acceptable is the discriminant validity, specifically the heterotrait-monotrait ratio (HTMT). This is an indicator that allows the correlation of each of the variables with each other to identify that there are no high correlations between them. This is to demonstrate that these variables are, to some extent, independent of each other. As can be seen in Table 4, all the values are less than 0.90, which implies that they are acceptable results for measuring the proposed research model (Henseler et al. 2009).

Table 4. Discriminant validity.

	UP	**AC**	**TA**	**AP**	**C**	**R&D**	**P**
UP							
AC	0.69						
TA	0.67	0.45					
AP	0.81	0.64	0.58				
C	0.81	0.69	0.60	0.78			
R&D	0.61	0.48	0.66	0.66	0.56		
P	0.66	0.49	0.60	0.72	0.60	0.71	

Note: Source: own elaboration with Smart-PLS V 4 data.

4.5. Model Verification

Figure 2 shows the structural equation model, where each of the latent variables used are presented, as well as the observable variables that conform to the proposed model to test the research hypotheses.

The first of the estimated parameters, R^2, of the research and development (R&D) variable is 0.51, which represents that these variables are explained by 51% of each of the components of the knowledge management process. It should be mentioned that there may be other variables that could help explain the rest of the R&D phenomenon.

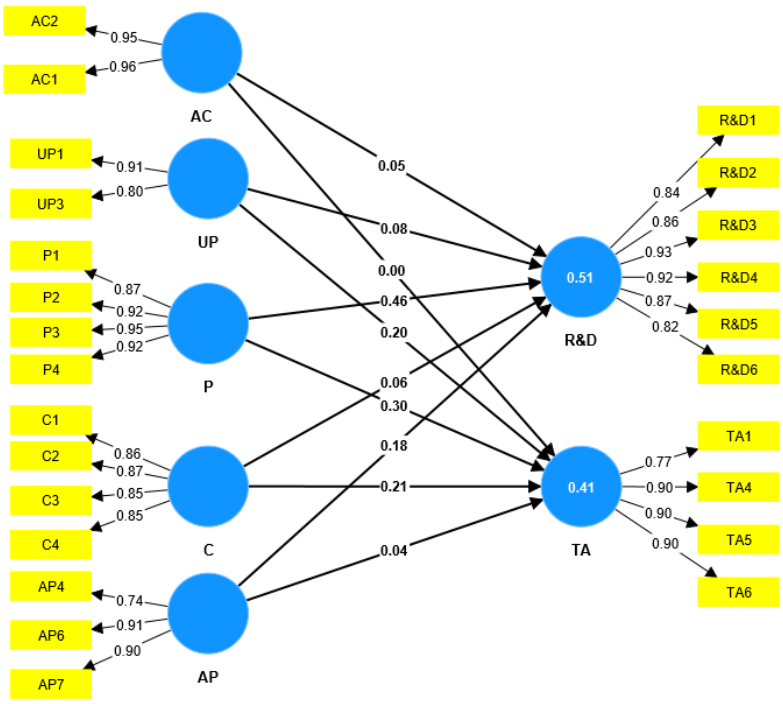

Figure 2. Model verification. Note: Source: own elaboration using data from Smart-PLS V. 4.

The second estimated parameter is the R^2 of the variable TA (technology acquisition), whose value is 0.41, which implies that this variable is explained by 41% of the components of the knowledge management process. As in the explanation described in the previous paragraph, there may be other variables that could explain the rest of the behavior of the technology acquisition variable.

In addition, Figure 2 shows the path coefficients of each of the independent variables with respect to the two dependent variables proposed in the research model. It can be seen how five of these path coefficients can be considered relevant in their effect on the dependent variables. For example, the variable, knowledge updating, has an effect of 0.20 on the activity of technology acquisition; knowledge application has a direct effect of 0.18 on the activity of research and development; it also shows how knowledge conversion has a direct effect of 0.21 on the activity of technology acquisition; finally, knowledge protection has a direct effect of 0.30 and 0.46 on the activities of technology acquisition and research and development, respectively.

On the other hand, Figure 2 shows how some path coefficients, although they present positive values, can be considered irrelevant for the explanation of the dependent variables proposed, due to their close value to zero. For example, the model shows that knowledge updating, knowledge acquisition and knowledge conversion have an effect on R&D activity of 0.08, 0.05 and 0.06, respectively, which represent very low values to explain the research phenomenon. In addition, the path coefficient obtained when evaluating the effect of knowledge application on the technology acquisition activity is 0.04, so it cannot be considered a relevant effect. Finally, the model shows that the effect of knowledge acquisition on the technology acquisition activity is null when calculating this path coefficient with a value of 0.00.

Considering the above, the following presents the verification of each of the hypotheses of the study, where the fulfillment of each one of them is analyzed, and it is observed that nine of them are accepted (see Table 5).

Table 5. Hypothesis Testing.

Hypothesis	Result
H1. Knowledge acquisition positively and significantly influences research and development.	Accepted
H2. The updating of knowledge has a positive and significant influence on research and development.	Accepted
H3. Knowledge protection has a positive and significant impact on research and development.	Accepted
H4. Knowledge conversion positively and significantly influences research and development.	Accepted
H5. The application of knowledge positively and significantly influences research and development.	Accepted
H6. Knowledge acquisition positively and significantly influences technology acquisition.	Rejected
H7. The updating of knowledge has a positive and significant influence on the acquisition of technology	Accepted
H8. Knowledge protection has a positive and significant influence on technology acquisition.	Accepted
H9. Knowledge conversion positively and significantly influences technology acquisition.	Accepted
H10. The application of knowledge positively and significantly influences the acquisition of technology.	Accepted

Note: own elaboration.

5. Discussion and Conclusions

The initial purpose of the study was to focus on the KMPC process in a general approach and related to seven activities that generate innovation. However, the objective of the research took another turn when the following premise was discovered: The empirical evidence shows that only a minority of firms is engaged in formal R&D activities (Legros and Galia 2011). It was then directed to discover how industrial companies are influenced by knowledge capabilities in relation to R&D and technology acquisition, as there are studies, such as Mete and Belgin (2021), which mention that no significant relationship could be found between knowledge management strategy and knowledge conversion in manufacturing companies.

Therefore, the research results detect empirical evidence for the dimensions of the conversion, updating and protection capabilities of the process focused on innovation-generating activities. Therefore, Hypotheses H7, H8 and H9 are highlighted, which showed higher indices in terms of relationship and influence, affirming that, by updating knowledge, adequate documentation of the processes is followed based on the current technology, and is finally expressed in technological projects (Snowden 2003). This is in agreement with the authors (Tiwari 2022; Obeidat 2019; Caldas and Ataide Candido 2013) who mention a high relationship between these variables, which is different from the results of Van Oorschot et al. (2018), which state that knowledge protection reduces, rather than increases, the ability to share new knowledge in the future in industrial companies. Regarding the protection and conversion of knowledge, companies see it as important to generate their patents and industrial protection, and transfer them to technological development, accepting the premise of Hsieh (2007), that no organization should stop the protection of knowledge, and that it can be stored and converted using communication tools and media such as email, cloud storage systems and network infrastructure (Hassan et al. 2017).

On the other hand, the application of knowledge has a considerable influence on research and development (H2), since, in Mexican industry, entrepreneurs see the need to increase the use of the application of knowledge for the development of innovations in the processes that allow for increasing and/or generating competitive advantages for the

organization based on learning and performance (Leber et al. 2015; García 2007). Similarly, it should be noted that the rejected hypothesis (H6) within Mexican industry is not relevant, since the acquisition of knowledge does not influence whether they adopt technology or incorporate it; rather; they need the acquisition of knowledge for their development, and they carry out that technology transfer.

Another important aspect highlighted in the study is the low relationship between innovation capabilities and technology acquisition, which may be due to the fact that companies in Mexico do not have specialized knowledge regarding the updating of their technological equipment for the optimal development of production. It is similar to the findings of Kang et al. (2015), who mention that the acquisition of external technology should be seen as a double-edged sword and that managers should be aware of the potentially negative effects of the great diversity of the company's external technology acquisition sources on internal R&D and subsequent innovation performance. Another interesting aspect to discuss is the relevance and high degree of explanation that knowledge capabilities have in these two innovation activities since they represent 40% of the explanation of the organizational phenomenon, and the remaining could be found in other innovation activities such as training, technical advice, marketing activities and engineering and industrial design activities. For this reason, the analysis focused on these activities specifically to know how they are involved in the processes of industrial companies in Mexico.

It should be noted that one of the important limitations in the study is that a considerable part of the sample belongs to the category of micro-enterprises, which, by their nature, do not have formally established processes and, in this aspect, it was somewhat complex to obtain the information. In this sense, there is an opportunity for research growth in which it would be appropriate to explore new sectors or organizations in the commercial sector or, very specifically, those organizations that use software as their main products and services and have greater customer–company relationships, since sharing knowledge allows companies to satisfy customer demands more quickly and achieve their business objectives (Tiwari 2022).

The industrial sector in Mexico is barely explored in terms of organizational variables; it has no formal knowledge generation processes and is unaware of the importance of updating knowledge in the areas of technology and R&D. Similarly, it is not known what R&D activities the companies generate, whether they have a specialized department for this purpose, or how they generate their industrial properties through patents. Likewise, it is not known what R&D activities are generated or whether a specialized department is created for this purpose, nor how industrial assets are generated through patents. Therefore, for an adequate complement to the present research, a qualitative analysis could be carried out in which a closer follow-up of the organizational areas of the industry can be made, to know their positions, opinions and internal processes.

In this regard, when studying industrial companies in Mexico, it is necessary to detect how much innovation capacity they have by relating their main innovation-generating activities, such as R&D and technology acquisition, since this could be a practical implication for the future, as in the study by Wang et al. (2020), where they had to evaluate the companies' specific conditions and the possible substitution effect of internal R&D activities and external knowledge acquisition.

The important contribution of this research is considered the analysis of knowledge capabilities separately. In most of the research studies taken as references for the paper, the analysis of the knowledge management variable, as a whole process, is observed, from the creation to the application of knowledge and related to innovation capabilities, such as processes, products or services. In this case, the important contribution is the analysis of each dimension of KMPC and its effect on possible future research that can be exercised, as, for example, the analysis of knowledge protection and its effect on the industry of other countries.

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