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ORIGINAL

Relationship between absorptive capacity and innovation capacity in firms: An empirical analysis using PLS-SEM

Relación entre la capacidad de absorción y la capacidad de innovación en las empresas: Un análisis empírico mediante PLS- SEM

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ABSTRACT

Small and medium-sized enterprises (SMEs) constitute a fundamental part of any country's economic structure, representing self-employment initiatives that generate jobs and contribute significantly to the Gross Domestic Product (GDP). However, due to the high level of competition they face, they experience limited growth and a low adoption rate of innovations, which in many cases leads to their short-term demise. Hence the importance of their capacity to absorb external knowledge, which allows them to adapt to changes in the environment and create innovations that enable them to compete in today's turbulent economic and financial market. In this context, the present study focuses on analyzing the relationship between the absorptive capacity and the innovation capacity of SMEs in the state of Sinaloa, Mexico. The method applied was PLS-SEM structural equation modeling, with a statistical sample of 151 companies. The results suggest that SMEs prioritize the assimilation and transformation of knowledge to foster innovation, particularly in their innovative performance, innovation culture, process innovation, and service innovation. The study's contributions include the theory of dynamic capabilities for organizations, as well as sufficient empirical evidence to demonstrate the correlation between absorption and innovation that streamlines the design of business strategies.

Keywords: Absorptive Capacity; Innovation; Strategy; SME; PLS-SEM.

RESUMEN

Las Pequeñas y Medianas Empresas (PYMES) forman parte importante de la estructura económica de cualquier país, pues representan iniciativas de autoempleo que generan puestos de trabajo y contribuyen de manera significativa al Producto Interno Bruto (PIB). Sin embargo, debido a la alta competencia a las que se enfrentan, tienen un limitado crecimiento y ausencia de adopción de innovación, que en muchos casos deriva de su desaparición en el corto plazo. De allí surge la importancia de la capacidad de estas de absorber conocimientos externos que les permitan adaptarse a los cambios en el entorno y crear innovaciones que les permitan competir en un mercado actual de turbulencia económica y financiera. A partir de lo anterior, el siguiente estudio se enfoca en analizar la relación entre la capacidad de absorción y la capacidad de innovación de las PYMES en el estado de Sinaloa México. El método aplicado fue la modelización de ecuaciones estructurales PLS-SEM, con una muestra estadística de 151 empresas. Los resultados sugieren que las PYMES priorizan la asimilación y transformación del conocimiento para fomentar la innovación, particularmente en su desempeño innovador,

la cultura de innovación, la innovación en procesos y la innovación de servicios. Los aportes del estudio incluyen a la teoría de capacidades dinámicas para las organizaciones, asi como la evidencia empírica suficiente para probar la correlación entre la absorción y la innovación que agilizan el diseño de estrategias empresariales.

Palabras clave: Absorción; Innovación; Estrategia; Pyme; PLS-SEM.

INTRODUCTION

In a business environment characterized by rapid and constant change, organizations are forced to incorporate innovation into their core strategies, as it is an essential element for generating favorable economic and financial results. Under this premise, according to academic literature, small and medium-sized enterprises (SMEs) lack a structure that allows them to maximize innovation, as their main characteristics include limited access to financing, limited use of technology, and poorly qualified personnel, among others. In short, during the COVID-19 pandemic, these organizations experienced a massive drop in demand for their products and services due to lockdowns and changes in consumer behavior,[1] which demonstrated the fragility of their organizational structure.

Consequently, these organizations must incorporate the development of dynamic capabilities and strategic agility into their business strategies, as both elements have become factors for the success of SMEs in turbulent scenarios, allowing them to respond to challenges and maintain their competitiveness during adverse situations.[2]

On the other hand, not all the characteristics of these organizations are negative; they also stand out for their flexibility and ability to adapt to market changes, which in turn makes them a driver of economic progress in the countries where they operate.[3] Furthermore, they are becoming increasingly important for the economic growth and innovation of countries,[4] and the latter has also become a priority for business development.[5] In this sense, given that innovation is a collective and social process, companies require networks that allow them to access the resources, knowledge, ideas, and information that are essential for their development. Thus, innovation is a factor in improving the performance of organizations.

Innovation is no easy task and requires companies to have high levels of knowledge absorption in order to achieve better results in product, process, and overall management innovation. Furthermore, the capacity for knowledge absorption allows companies to respond to constant changes in their environment.[6] Therefore, organizations must rely on ambidextrous capabilities to face environmental uncertainty, and this is achieved by taking advantage of external opportunities, such as the use of internal resources , in order to adapt to market transformations and environmental threats.[7]

In addition, the knowledge-based perspective argues that organizations with different knowledge bases differ in their innovation, as broad and deep knowledge improves innovative practices.[8] Therefore, absorption capacity is a critical factor for the innovative capabilities of companies, since developing innovation requires prior knowledge that is adaptable and applicable to new information for the development of new knowledge or the improvement of existing knowledge.[9]

In this sense, authors such as González et al.[10] unify absorptive capacity and innovation capacity as codependent on each other, since innovation itself becomes a long process of knowledge accumulation that is summarized in the term absorptive capacity.

On the other hand, the dimensions related to knowledge absorption capacity begin with the acquisition of knowledge, which consists of recognizing and obtaining relevant external knowledge. Assimilation, on the other hand, focuses on analysis and understanding, while transformation involves integrating new knowledge with existing knowledge in the organization. Finally, exploitation relates to applying the acquired knowledge within the business context.[11]

Specific studies such as suggest that absorptive capacity has a positive influence on business innovation.[12] One aspect that enables innovation in organizations is the ability to assimilate knowledge, since not all organizations have the possibility of acquiring external knowledge and mastering it in order to transform it into new routines or processes.[13]

This study is based on the central idea that the way organizations acquire, assimilate, transform, and exploit knowledge directly influences their capacity to innovate. Consequently, when a company effectively manages external and internal knowledge, it can improve its innovative performance, strengthen its culture of innovation, and develop improvements in its products and services, as well as in its processes and use of technology. Under this premise, the research aims to identify the relationship between the dimensions of innovation and the capacity for knowledge absorption in SMEs.

Given all of the above, it is necessary to justify the research due to the characteristics of SMEs in Sinaloa, Mexico, where the adoption and development of technology has been a priority for their survival in recent

years.[14] In addition, this study aims to contribute to the theoretical body of knowledge by demonstrating the relationship between both types of dynamic capabilities, with the objective of addressing the gap identified in this relationship based on the analysis of a specific sample of SMEs.

METHOD

Table 1 below shows a summary of the variables corresponding to absorption capacity and innovation capacity, including each of their dimensions, i.e., the acquisition, assimilation, exploitation, and transformation of knowledge, as well as innovative performance, innovation in products and services, innovation in processes, the culture of innovation, and technological innovation. The study was conducted on a universe of 136,332 companies located in the state of Sinaloa, classified as micro, small, and medium-sized enterprises, according to the Official Gazette of the Federation (DOF), from which a representative sample of 151 SMEs was obtained. These surveys were administered to owners and decision-makers over a period of one year, using information provided by the National Institute of Statistics and Geography (INEGI), which includes the stratification of companies, telephone numbers, and email addresses.

The method used is partial least squares structural equation modeling (PLS-SEM), which allows for the evaluation of the causal relationship between constructs or latent variables (15,16). In other words, the model will allow for a complete evaluation of each of the proposed variables and dimensions and thus provide answers to the research hypotheses presented. Once the answers were obtained for analysis, Smart PLS version 4 software was used.

Table 1. Description of the variables, dimensions, and indicators of the research

Variables	Dimensions	Abbreviations
Absorption capacity	Acquisition	CAADQ
	Assimilation	CAASI
	Exploitation	CAEX
	Transformation	CATRA
Innovation Capacity	Innovative Performance	CIDIN
	Innovation in products and services	CIEPR
	Process Innovation	CINPS
	Culture of Innovation	CACUI
	Technological innovation	CIINT

First, the validity of the model (convergent and discriminant validity, reliability and composite reliability, AVE) was evaluated, as shown in table 2. Validity determines whether a scale accurately measures the concept it intends to measure, while reliability refers to the consistency and stability of a measurement instrument. Reliability is a prerequisite for validity, since an unreliable scale cannot be valid. Adequate results are presented in terms of internal consistency and measurement stability. First, Cronbach's alpha ranges from 0,777 to 0,8883, exceeding the minimum accepted threshold of 0,70.

Table 2. Construct validity and reliability test

	Cronbach's alpha	Compound reliability (rho_a)	Compound reliability (rho_c)	Average extracted variance (AVE)
CAADQ	0,777	0,819	0,854	0,596
CAASI	0,874	0,875	0,913	0,725
CACUI	0,881	0,885	0,927	0,808
CAEX	0,811	0,816	0,888	0,726
CATRA	0,803	0,808	0,883	0,716
CIDIN	0,779	0,781	0,871	0,693
CIEPR	0,878	0,882	0,916	0,733
CIINT	0,871	0,875	0,912	0,722
CINPS	0,883	0,892	0,915	0,683

Table 3 shows the composite reliability (ρh and ρc) between 0,781 and 0,927, which exceeds the criterion of 0,70, confirming that the latent variables are measured reliably and that the indicators show high consistency

within each dimension. Finally, the convergent validity of the mean extracted variance (AVE) values is between 0,596 and 0,808, all of which are above the threshold of 0,50, indicating that more than 50 % of the variance of the indicators is explained by the corresponding construct.

Table 3. Heterotrait-Monotrait Ratio Matrix (HTMT)

	CAADQ	CAASI	CACUI	CAEX	CATRA	CIDIN	CIEPR	CIINT	CINPS
CAADQ									
CAASI	0,905								
CACUI	0,533	0,565							
CAEX	0,817	0,881	0,610						
CATRA	0,740	0,826	0,683	0,889					
CIDIN	0,582	0,616	0,743	0,619	0,810				
CIEPR	0,654	0,658	0,856	0,676	0,762	0,811			
CIINT	0,618	0,604	0,692	0,529	0,554	0,597	0,675		
CINPS	0,664	0,692	0,737	0,649	0,733	0,869	0,869	0,589	

In general, the values show that the coefficients are below 0,90, indicating adequate discrimination between the constructs. Only the correlation between assimilation capacity and knowledge acquisition capacity, at 0,905, suggests a high conceptual correlation between these dimensions; however, this does not represent a critical threat to the model.[17] This is because the results for absorption capacities range between 0,82 and 0,90, reflecting an underlying phenomenon related to knowledge and innovation capacities greater than 0,80.

Table 4 shows the results of the structural relationships of the model obtained through the PLS-SEM method. The criterion for accepting the hypothesis was established by considering a significance level of P<0,05, which highlights a significance between the latent variables.

Table 4. Path coefficients (mean, standard deviation, t-values, p-values)

	Original Sample (O)	Sample Mean (M)	Standard Deviation (Stdev)	T Statistics (|O/Stdev|)	P-Values	Result
CAADQ -> CACUI	0,108	0,114	0,109	0,988	0,323	Rejected
CAADQ -> CIDIN	0,129	0,129	0,107	1,206	0,228	Rejected
CAADQ -> CIEPR	0,204	0,209	0,087	2,331	0,020	Accepted
CAADQ -> CIINT	0,249	0,250	0,127	1,957	0,050	Accepted
CAADQ -> CINPS	0,188	0,187	0,114	1,658	0,097	Rejected
CAASI -> CACUI	0,050	0,044	0,132	0,375	0,708	Rejected
CAASI -> CIDIN	0,045	0,053	0,127	0,353	0,724	Rejected
CAASI -> CIEPR	0,072	0,067	0,113	0,640	0,522	Rejected
CAASI -> CIINT	0,239	0,240	0,158	1,515	0,130	Rejected
CAASI -> CINPS	0,212	0,215	0,132	1,600	0,110	Rejected
CAEX -> CACUI	0,129	0,131	0,116	1,116	0,264	Rejected
CAEX -> CIDIN	-0,018	-0,021	0,111	0,159	0,874	Rejected
CAEX -> CIEPR	0,088	0,087	0,104	0,839	0,401	Rejected
CAEX -> CIINT	-0,010	-0,014	0,129	0,080	0,937	Rejected
CAEX -> CINPS	0,009	0,007	0,119	0,074	0,941	Rejected
CATRA -> CACUI	0,390	0,391	0,119	3,286	0,001	Accepted
CATRA -> CIDIN	0,555	0,554	0,092	6,048	0,000	Accepted
CATRA -> CIEPR	0,413	0,415	0,110	3,760	0,000	Accepted
CATRA -> CIINT	0,156	0,161	0,126	1,246	0,213	Rejected
CATRA -> CINPS	0,366	0,368	0,104	3,509	0,000	Rejected

RESULTS

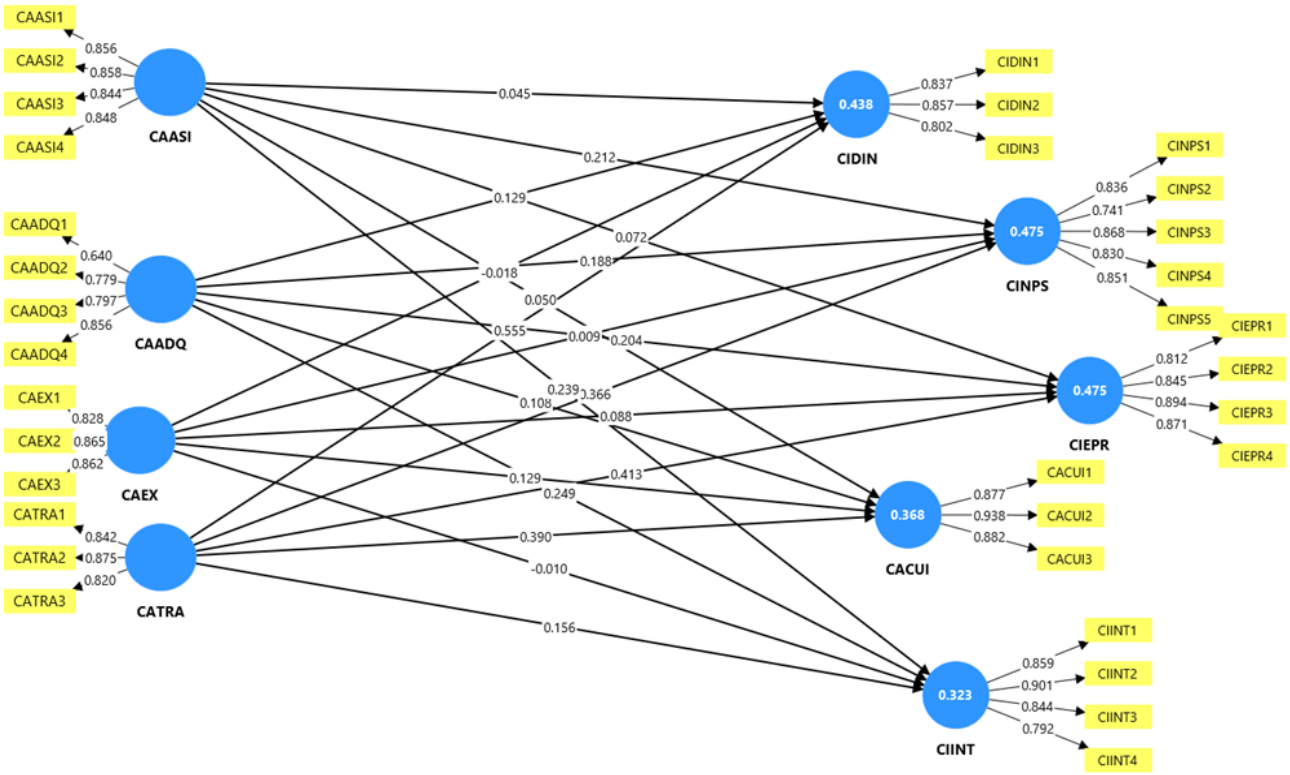

Figure 1. Structural model

DISCUSSION

The results of this study suggest that absorption capacity plays a mediating role in innovation capacity, an aspect that is prioritized in environments characterized by high market dynamism.

Previous studies using this same methodology have highlighted the importance of absorptive capacity in organizational performance and, consequently, in the development of innovation.[18] Others consider absorptive capacity to be what allows organizations to be competitive regardless of their size.[19] Previous studies linking the variables of absorption and innovation suggest that technological absorption capacity has an indirect impact on the business performance of SMEs, as measured by innovation in e-commerce,[20] while other studies suggest that there is a positive and significant relationship between absorption capacity, innovation, and technology to improve the business performance of SMEs.[21]

More specifically, studies such as [22] suggest that the acquisition, assimilation, transformation, and exploitation of knowledge of the environment enable companies to participate in innovation strategies. Meanwhile, the development of technological innovations is carried out through the process of adopting external and experimental knowledge across the dimensions of absorption capacity.[23]

Firstly, the study observes that acquisition capacity has a positive and significant effect on the innovation process (β = 0,204; t = 2,331; p = 0,020) and on technological innovation (β = 0,249; t = 1,957; p = 0,050). In this sense, knowledge acquisition suggests that SMEs do manage to identify and capture relevant knowledge from their environment, but face challenges in internalizing it.

Assimilation capacity (CAASI) does not show any significant relationship with the dimensions of innovation. Similarly, exploitation capacity (CAEX) also has no positive relationship with any of the variables previously analyzed. For its part, transformation capacity (CATRA) is the most influential variable of absorption capacity, i.e., it drives the types of innovation even more than the culture of innovation (t=3,286, p=0,001), innovative performance (t=6,048, p=0,000), process innovation (t=3,760, p=0,000), and service innovation p<0,05.

Overall, the model explains between 32 % and 47 % of the variance in innovation capacity, suggesting that there is a relationship with absorptive capacity, but not an exclusive one, as other aspects may influence its internalization in organizations.

The results confirm the assumptions of dynamic capabilities theory, where absorptive capacity acts as a antecedent of the organization. It is also consistent with research by authors such as (14) (15), who assert that for organizations to generate sustained innovation, the assimilation and exploitation of external knowledge is necessary. In general, it can be said that innovation does not arise spontaneously, but rather through an accumulation of knowledge that translates into strategic thinking.

Furthermore, it is important to note that for SMEs to innovate, they require sources of internal and external knowledge. Therefore, as they do not have sufficient resources for innovation on their own, they require external sources of knowledge, including collaboration with suppliers and competitors.[23]

The practical implications of the study suggest that SMEs should invest in organizational learning mechanisms and strategies that include training, business networks, and strategic alliances to strengthen their absorption capacity, while internally promoting knowledge exchange between different departments within organizations can have greater results in innovation.

CONCLUSIONS

The study's findings identified patterns of how absorptive capacity and innovation capacity are related so that SMEs in Sinaloa acquire knowledge, which in turn is converted into different types of innovation. In general terms, it was observed that not all dimensions of absorptive capacity strengthen innovation, while the acquisition and exploitation of knowledge is more closely related to process innovation, the culture of innovation, and the innovative performance of these organizations.

The set of results highlights the importance of consolidating absorption capacity that allows for the potential of knowledge and innovation to recognize one's own skills within the organization. It is recommended that organizations strengthen their capacity to assimilate and exploit knowledge, as well as promote knowledge management mechanisms that include staff training, formalization of learning routines, and inclusion of a culture of innovation within business strategies.

In the current context, including innovation within organizational strategies has become a priority. Therefore, those organizations that effectively leverage the principles and elements of innovation and continuous learning are more likely to generate value and obtain sustainable competitive advantages. The methodology used to evaluate the relationship between the study variables contributes to the study of dynamic capabilities. However, it has limitations that must be taken into account, primarily the context of SMEs in Sinaloa, which includes violence and economic crisis. Therefore, for future research, it is recommended that the study be replicated in other states of the Mexican Republic.

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