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The innovation of mexican micro, small & medium-sized enterprises. Empirical evidence through the structural equation modeling

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Resumen

Hoy en día, la innovación se ha convertido en una estrategia que permite a las empresas a mejorar su nivel competitivo. Por esta razón, el objetivo del presente estudio explicativo empírico fue analizar el nivel de innovación de la fabricación de la Micro, Pequeña y Mediana Empresa de tamaño (MIPYMES) en el estado de Aguascalientes, México. Una encuesta se administró a 150 gestores de MIPYMES, cuyas escalas de medición se sometieron a un análisis factorial confirmatoria Segunda Orden (CFA), a través del método de máxima verosimilitud, que tiene tanto la fiabilidad y la validez convergente y discriminante. Los resultados obtenidos a través de la ecuación de Modelado Estructural (SEM) permiten inferir que las MIPYMES en Aguascalientes dar más importancia a la innovación en productos y procesos, lo que les permite comercializar nuevos productos o servicios de acuerdo a las necesidades de sus clientes y ser más flexible a los cambios en sus procesos.

Innovación, fabricación MIPYMES, análisis factorial confirmatorio, modelos de ecuaciones estructurales.

Abstract

Nowadays, innovation has become a strategy that allows companies to improve their competitive level. For this reason, the purpose of the present empirical explanatory study was to analyze the innovation level of manufacturing Micro, Small and Medium-size Enterprises (MSMEs) in the state of Aguascalientes, Mexico. A survey was administered to 150 MSMEs managers, whose measurement scales were subjected to a Second Order confirmatory factor analysis (CFA), through the maximum likelihood method, which has both reliability and convergent and discriminant validity. The results obtained through the Structural Equation Modeling (SEM) allow us to infer that MSMEs in Aguascalientes give more importance to innovation in products and processes, allowing them to market new products or services according to the needs of their customers and being more flexible to changes in their processes.

Innovation, manufacturing MSMEs, Confirmatory Factor Analysis, Structural Equation Modeling.

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Introducción

As a result of globalization and high competition that has marked the environment, businesses, especially micro, small and medium enterprises (MSMEs) require rethinking their business strategies in order to meet market expectations. For this reason, these businesses must have the ability to develop and commercialize innovative products and thereby bolster its global competitiveness (Backman, Borjesson & Setterberg, 2007; Meade & Presley, 2002).

Also, Greve & Taylor (2000) note that product innovation makes it easier for companies to enter into new industries, as well as to obtain competitive advantage over their competitors. That is why product innovation is characterized as being critically important to the performance of companies (Cho & Pucik, 2005).

However, according to Maldonado, Martinez & Garcia (2011) a large number of SMEs in Mexico do not perform any kind of innovative activity in their products or services, let alone in their processes, and perhaps these businesses are more focused on their daily sales enabling them to obtain the necessary income for payroll rather than in strategic matters of their business, noting that in Mexico more than 50% of SMEs are family businesses, in which the manager is the person in charge of sales, purchasing, finance, accounting, marketing and other activities that are required for the organization to function.

Also, it is noteworthy that most innovation studies have focused on large enterprises, which by its organizational structure and market oriented character are by nature inherently innovative (Hadjimanolis, 2000).

In this situation, the empirical evidence that the investigation provides is utterly important, as there have been few studies in developing countries about the level of innovation in MSMEs, and the results of research conducted in developed countries may not always apply to the developing countries (Casanova, 2004; Cuervo-Cazurra, 2008), since their economic behavior is very different, and there is usually an unstable and chaotic environment, poor educational and political systems, and a low industrialization level, including development (Jarvenpaa & Leidner, 1998). Therefore, an additional contribution of this study, on top of its application in MSMEs in a developing country, such as Mexico, is the application of the statistical technique of Structural Equation Modeling.

Thus, this research has set forth the objective to analyze the level of innovation in manufacturing MSMEs of the state of Aguascalientes, Mexico, and it is therefore important that the researcher questions on one hand which of the three latent variables best explains the level of innovation in these types of businesses and on the other hand whether these variables are significant. In this sense, the research was conducted in the state of Aguascalientes with a sample of 150 MSMEs, whose surveys were applied to the managers of such companies in a period between September and November 2012. This research is divided into five parts: the first part consists of the introduction; the second covers the review literature and the formulated hypothesis; Part three contains the methodology; the fourth part, the research analysis, results and discussion; the fifth part, the conclusions, limitations of the study and further lines of research.

1 Literature review

The development of this research model describes the relationship of product innovation, process innovation and innovation in management systems, as latent variables of innovation activities in MSMEs; it is why in the following sections the various components of the model under study are intended to be clarified, with the intention of supporting the approaches and results.

Product innovation.

For Bisbe & Otley (2004), product innovation is regarded as the development and marketing of products that are unique and distinctive in some way from already existing ones in the market.

Damanpour (1991) and Rogers (1995) argue that innovation refers to the adoption of an internally generated or acquired product which is new to the adopting company. There are quite substantial arguments and evidence of the importance of product innovation for organizations. Product innovation is seen as an important way for organizations to adapt effectively to changes in markets, technology and competition, as well as in taking preventive measures to influence the environment in which they operate (Bisbe & Otley, 2004).

The literature indicates that the acceleration in the pace of technological development, the shortest life cycles of a product, and global competition is forcing companies to ever more increasingly resort to innovative products as a key engine of benefits, both locally and international (Cho & Pucik, 2005; Katila & Chen, 2008). In the early 90's, Robinson & Pearce (1988) found that there is a positive and significant relationship between product innovation and the level of business performance.

However, Misra, Kim & Lee (1996), according to the results in their research, concluded that the greater the frequency with which companies innovate their products, the higher the frequency of failure will be as well. This shows that most of the theoretical and empirical studies published in the literature, show the positive relationship between product innovation and business performance, but there is also evidence in the literature of the negative relationship between these two important constructs, which demonstrates the importance of this study.

In another research study, Aboulnasr, Narasimhan, Blair & Chandy (2008) found that innovation occurs through the application of new and creative ideas that constantly seek to improve, design a product or generate a completely new product, but these applications are always based on company performance goals.

Therefore, for a product innovation to have the desired success it is necessary to meet the satisfactory needs and / or likings of the consumer which are changing constantly, so a proper investigation into market trends will be needed as well as the competitive strength that also affect the performance of innovations (Dunk, 2011; Tung, 2012). From the above, the following hypothesis is proposed:

H_1: The greater product innovation, the greater innovation in manufacturing MSMEs of Aguascalientes.

Processes innovation.

Just as new products in the market are seen as the pinnacle of innovation, the process plays a strategic role of equal value (Tidd, Bessant & Pavit, 2003).

That is why process innovation is typically applied in the organization while on the contrary, product innovations or service is market oriented (Freire, 2000).

The term process innovation includes new labor forecasting strategies, the current process activity and the implementing of change within the complex human, technological and organizational dimensions (Davenport, 1993).

It is therefore important to emphasize that organizational skills associated with process innovation are technology oriented as well as the ability to develop improvements and the marketing of products.

Maldonado, Madrid, Martinez & Aguilera (2009) in their empirical research conducted with four hundred SMEs in Aguascalientes in seeking to analyze the effect that cause different types of innovation in the performance of these businesses, found that companies that innovated in processes improved their efficiency in organizing tasks (internal processes).

For its part Heunks (1998) in his research with 200 companies from six countries, in analyzing how creativity and innovation are interrelated in the path to organizational success, found that innovation of any kind encourages performance in small companies, but only process innovation boosts productivity thereof. Similarly Menéndez, López, Rodríguez & Francesco (2007) in their study with Spanish companies, found that process innovation linked to the use of new technologies, particularly to ICT in relation with customers and suppliers, positively affect the performance of companies.

Meanwhile Goedhuys & Veugelers (2012), in their study conducted with 1563 Brazilian manufacturing companies found that innovation process is positively and significantly related to sales growth, but process innovation alone without the introduction of new products risks being ineffective to achieve further growth; and that the innovative performance of different innovative strategies such as process innovation, two thirds of companies reported having successfully introduced new processes during the period of 2000-2002, and those that did not have an innovative strategy were less likely to introduce new processes. That is why the above proceeds to formulate the following hypothesis:

H_2: The greater innovation in processes, the greater innovation in manufacturing MSMEs of Aguascalientes.

Management systems innovation.

Fernández & Peña (2009) in the results of their empirical research on the effect of technological innovation strategy, which 62 Spanish cooperatives were used as sample, found significant positive evidence of the effect innovation strategy has on company performance, and determined that the development of a formal strategy for technological innovation is of great importance for obtaining competitive advantages for the organization. Similarly, in their empirical research conducted with four hundred SMEs in Aguascalientes, Maldonado et al. (2009) found that companies that innovated management systems, improved their position in market share and profitability (rational system).

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Meanwhile Galvez & Garcia (2012) in their research conducted with 60 Colombian MSMEs from medium and high technology found that innovation in management systems shows no significant effect on the performance of these businesses, however, it does so in the innovation of products and processes. From the above, the following hypothesis is proposed: H_3: The greater innovation management systems, the greater innovation in manufacturing MSMEs of Aguascalientes. Based on the presented theoretical foundation, Figure 1 shows the theoretical model that gives rise to this research.

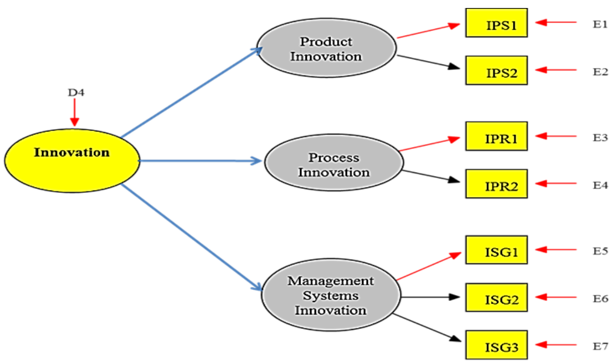

Figure 1

2 Methodological design

An empirical research was conducted with a quantitative explanatory approach and cross section through a Second Order Confirmatory Factor Analysis, since innovation activity is a variable that cannot be measured directly, but it has three factors which should be measured, which is why the structure of the model was tested through structural equation modeling (SEM). Sample Design and Data Collection.

The research instrument is composed of 7 items measured on a Likert type scale from 1 to 5, which refer from total disagreement to total agreement, which was applied to MSMEs managers in the manufacturing industrial sector of the state of Aguascalientes, Mexico.

The study analyzed product innovation, process innovation and innovation management systems to determine the level of innovation in these enterprises. For the development of this research the database that is featured by the 2014 business directory of Business Information System from Mexico (BISM) of the state of Aguascalientes was taken as reference, where until February 26 of that year, 793 industrial enterprises appeared registered, of which 510 companies are micro-sized, 179 are small companies and 71 companies are medium sized, therefore, 760 companies make up the universe of MSMEs, and the remaining 33 large sized companies were not considered in our universe for determining the sample. Similarly, the survey was designed based on the theoretical model, to be answered by the managers or owners of MSMEs in the manufacturing sector of the state of Aguascalientes, and was applied randomly, however, only a response rate of 58% was obtained with a 5% margin error at a 95% confidence level, which was applied from September to November of 2012, with a total count of 150 validated surveys. Information can be seen in Table 1, which refers to the research design.

Characteristics	Investigation
Population*	760 Micro, small and medium-sized enterprises
Geographical Area	The state of Aguascalientes, México
Object of study	Manufacturing MSMEs from 5 to 250 employees
data collection method	Personal interviews with Managers
Sampling Method	Simple random sampling
Sample size	256 SMEs
Sample Error	±5% error, reliability level of 95% (p=q=0.5)
Response rate	59% = 150 valid surveys
Fieldwork	September through November 2012

Table 1

For the preparation of the measuring instrument the block referring to innovation activities was used in where three factors were considered which are product innovation, process innovation and innovation management systems adapted from (Madrid-Guijarro et al., 2009), and tested in other empirical studies by Cuevas et al. (2014) and Galvez & García (2012), in which product innovation was measured with a scale of 2 items, process innovation was measured with a scale of 2 items, and innovation management systems were measured with 3 items, same which were subjected to a reliability analysis.

Reliability and validity.

To assess the reliability and validity of the scales a Confirmatory Factor analysis (CFA) was performed using the maximum likelihood method in EQS 6.1 (Bentler, 2005; Brown, 2006; Byrne, 2006), working the theoretical model of innovation activities MSMEs of Aguascalientes, measured as second-order factor. Also, the reliability of the three proposed measurement scales was evaluated from the Cronbach's Alpha coefficients and Composite Reliability Index (CRI) (Bagozzi & Yi, 1988). All scale values exceeded the recommended level of 0.7 for the Cronbach´s Alpha providing evidence of reliability and justifying the internal reliability of the scales (Hair, Anderson, Tatham & Black, 1998; Nunally & Bernstein, 1994). Similarly, the robust statistics (Satorra & Bentler, 1988) will be used to provide better evidence of statistical adjustments.

Model settings. The settings that were used in the model under study were Normed Fit Index (NFI), the Non-Normed Fit Index (NNFI), Comparative Fit Index (CFI) and the Root Mean Square Error of Approximation (RMSEA) (Bentler & Bonnet, 1980; Hair et al., 1998).

Values NFI, NNFI and CFI between 0.80 and 0.89 represent reasonable adjustments (Segars & Grover, 1993) and a value equal to or greater than 0.90 are good evidence of a good adjustment (Byrne, 1989; Jöreskog & Sörbom, 1986; Papke-Shields et al., 2002). RMSEA values below 0.080 are acceptable (Hair et al., 1998; Jöreskog & Sörbom, 1986).

3 Results and discussion

Having applied the Second Order CFA, it was found that the original model did not present adjustment problems, since the model has a good fitting of the data referencing to the robust statistics (SB $X^2 = 20.512$, df = 11; $p = 0.038$; NFI = 0.959; NNFI = 0.962; CFI = 0.980; and RMSEA = 0.076), since the values NFI, NNFI and CFI are higher than 0.90, and RMSEA is less than 0.08, which are acceptable (Hair et al., 1998; Jöreskog & Sörbom, 1986), same as in Table 2, For which the original model has high setting rates and therefore the model has validity content; Likewise, not having eliminated any variable to the theoretical model because they all have factor loadings higher than 0.6 (Bagozzi & Yi, 1988), this indicates that the theory and reality match, since the theoretical model reflects the reality of what is measured.

As evidence of convergent validity, the results of CFA presented in Table 2 indicate that all related factor items are significant ($p < 0.001$), the size of all standardized factor loadings are greater than 0.60 (Bagozzi & Yi, 1988) and the average standardized factor loadings of each factor are highly superior to the value of 0.70 (Hair et al., 1998). As seen in the already cited Table 2, there is a high internal consistency of the constructs, since in each case the Cronbach´s Alpha exceeds the value of 0.70 recommended by Nunnally & Bernstein (1994).

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The composite reliability represents the extracted variance between the group of observed variables and the fundamental construct (Fornell & Larcker, 1981). Generally, a composite reliability index (CRI) greater than 0.60 is considered desirable (Bagozzi & Yi, 1988), in our study, this value is well above, since the lowest value obtained was 776 corresponding to the variable (construct) product innovation.The average variance extracted (AVE) was calculated for each of the constructs, resulting in an AVE higher than 0.50 (Fornell & Larcker, 1981) in each one of the factors.

Variable	Indicator	Factor Loading	Robust t-value	Average factor loading	Cronbach´s αlpha	CRI	AVE
Product Innovation (F1)	IPS1	0.732***	1.000 ª	0.794	0.771	0.776	0.635
	IPS2	0.857***	9.102				
Process Innovation (F2)	IPR1	0.801***	1.000 ª	0.797	0.777	0.777	0.635
	IPR2	0.793***	11.87				
Management Systems Innovation (F3)	ISG1	0.735***	1.000 ª	0.740	0.783	0.785	0.549
	ISG2	0.726***	9.686				
	ISG3	0.761***	10.17				
S-B X²= 20.512; df= 11; (S-B X²/df= 1.86); p= 0.038; NFI= 0.959; NNFI= 0.962; CFI= 0.980; RMSEA= 0.076							

Table 2

With regards to the discriminant validity evidence, the results obtained are presented in Table 3 where the measurement is provided in two ways, the first with a 95% reliability interval, none of the latent factors of the individual elements from the correlation matrix contain the value 1.0 (Anderson & Gerbing, 1988).

Second, the extracted variance between the pair of constructs is greater than its corresponding AVE (Fornell & Larcker, 1981).

Therefore, based on these criteria, it can be concluded that the distinct measurements performed in this investigation demonstrate sufficient evidence of reliability and convergent and discriminant validity of the adjusted theoretical model.

<table>
<tr><td>Variables</td><td colspan="2">Product Innovation</td><td colspan="2">Process Innovation</td><td>Innovation Management systems</td></tr>
<tr><td>Product Innovation</td><td colspan="2">0.635</td><td colspan="2">0.295</td><td>0.264</td></tr>
<tr><td rowspan="2">Process Innovation</td><td>lower limit</td><td>upper limit</td><td colspan="2" rowspan="2">0.635</td><td rowspan="2">0.305</td></tr>
<tr><td>0.351</td><td>0.735</td></tr>
<tr><td rowspan="2">Innovation Management systems</td><td>lower limit</td><td>upper limit</td><td>lower limit</td><td>upper limit</td><td rowspan="2">0.549</td></tr>
<tr><td>0.344</td><td>0.684</td><td>0.380</td><td>0.724</td></tr>
<tr><td colspan="6">NOTE: The diagonal represents the index of the extracted variance "AVE" below the diagonal part of the variance obtained by Confidence Interval Test is presented and above the diagonal the Extracted Variance Test results are presented through the squared covariance between each of the factors.</td></tr>
</table>

Table 3

Having applied the SEM, understood as multivariate techniques that combine aspects of multiple regression (examining dependency relationships) and factor analysis (representing immeasurable concepts with multiple variables) to estimate a series of dependency relationships interrelated simultaneously (Hair et al., 1998), using the statistical software EQS 6.1, from the application of second order CFA (Bentler, 2005; Byrne, 2006; Brown, 2006), with the same variables to check the structure of the model, the obtained results contrast the stated hypothesis, same hypothesis presented in Table 4.

Hypothesis	Path	Standardized Coefficients	Robust t-value	R square
H1: The greater product innovation, the greater innovation in manufacturing MSMEs	Product innovation → Level of innovation	0.328 ***	9.102	0.835
H2: The greater innovation in processes, the greater innovation in manufacturing MSMEs	Process innovation → Level of innovation	0.323 ***	11.873	
H3: The greater innovation management systems, the greater innovation in manufacturing MSMEs	Innovation management → Level of innovation	0.306 ***	9.931	
S-B X²= 13.0536; df= 7; (S-B X²/df= 1.864); p= 0.0708; NFI= 0.974; NNFI= 0.962; CFI= 0.987; RMSEA= 0.076				
*** = p < 0.001; ** = p < 0.05; * = p < 0.1				

Table 4

Finally, with regard to the assumptions made in this study, we proceed to its verification, with respect to H_1, the results obtained ($\beta = 0.328$, $p < 0.001$), indicating that the greater product innovation, the higher innovation of manufacturing MSMEs from Aguascalientes, therefore, the H_1 is accepted.

Regarding the H_2, the results obtained ($\beta = 0.323$, $p < 0.001$), indicating that the greater innovation in processes the greater innovation in manufacturing MSMEs from Aguascalientes, therefore, the H_2 is accepted; and as for the H_3, the results obtained ($\beta = 0.306$, $p < 0.001$), indicating that greater innovation management systems the greater innovation in manufacturing MSMEs from Aguascalientes, therefore, the H_3 is accepted.

According to the results, it is noteworthy that the greater innovation the products of MSMEs have the higher its level of innovation will be, however, it is necessary to meet the needs and / or consumer tastes which constantly keep changing, so adequate research on market trends will be required, corroborating the studies of Aboulnasr et al. (2008); Cho & Pucik, (2005), and Katila & Chen (2008), to coincide with them.

So too, when MSMEs have a higher level of innovation in their processes, the higher their level of innovation will be and it will be reflected in the results of the company by boosting their productivity coinciding with findings by Goedhuys & Veugelers (2012); Heunks (1998), and Maldonado et al. (2009); and finally, the greater the innovation management systems of MSMEs are, the higher its level of innovation will be, corroborating the results previously found by Fernandez & Peña (2009), Galvez & García (2012), and Maldonado et al. (2009).

4 Conclusions

Based on the results we have found that product innovation, process innovation and innovation management systems are three latent variables that measure the innovation level of MSMEs from the manufacturing sector in the state of Aguascalientes.

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Once companies have made some kind of innovation activity, they are more likely to achieve competitive success before those companies that have not (Cuevas et al., 2014) in a competitive global market as that faced today.

Likewise, the three first order latent variables, the most impacting in MSMEs innovation measuring is product innovation, indicating that according to the interpretation of the MSMEs studied, these types of businesses are less concerned with innovation management systems by giving greater importance to product innovation, followed by process innovation, indicating that MSMEs are more flexible to changes in their processes, so being that managers should take special care in this variable, allowing them to market new products or services according to the needs of their customers and thus achieve competitive success.

It is noteworthy that the three main items that explain the level of innovation in MSMEs of the state of Aguascalientes are the marketing of new products / services, changes or improvements in production processes / services and the acquisition of new equipment assets.

Therefore, we can conclude that manufacturing MSMEs from state of Aguascalientes pay more attention to the marketing of new products or services, to changes or improvements in production processes and the acquisition of new equipment assets in innovation activities that they perform and are less concerned in purchasing and supply, according to empirical evidence calculated through the second order statistical analysis. Within the constraints, we may highlight that the surveys were answered from the point of view of the MSMEs managers, which can lead to subjectivity.

Furthermore, it is suggested to evaluate the possibility of expanding the universe of study to consider other companies with other dimensions to increase the validity of the theoretical model used.

Finally, establishing new constructs are suggested with the variables used to extend the results and compare them with the conclusions set out in this article.

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