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Comparative study of innovation factors in the small and medium-sized textile manufacturing enterprise

Estudio comparativo de los factores de innovación en la pequeña y mediana empresa de manufactura textil

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Abstract

The context of innovation has changed and one economy that demands permanent adaptations should consider it as the principal core of its competitiveness; this requires improving its capabilities for innovation as a source of competitive advantage and survival strategy. The objective of this research was to determine what factors of innovation are statistically significant among small and medium-sized textile enterprises (SMEs) and how they influence their level of innovation, taking as object of study the textile sector in Tlaxcala, Mexico, considering the Gary Hamel´s factors. The methodology consisted in making a diagnosis on the perception of these factors through a measuring instrument. Subsequently, one-way analysis of variance, Tukey's test, Pearson correlation and linear regression were performed to determine the significance and the relationship between the variables. The results revealed that innovation factors are significant in both types of companies, as well as showing a strong correlation with its level of innovation. Likewise, a significant relationship was found between the level of innovation and the factors analyzed, it being observed that they are determinants in the medium company, but not in the small one. Concluding

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that SMEs should implement the innovation with a holistic and dynamic approach considering the factors proposed.

JEL Classification: L67, O30.
Keywords: Innovation, Innovation factors, SMEs.

Resumen

El contexto de la innovación ha cambiado y una economía que demanda adaptaciones permanentes debe posicionarla como eje de su competitividad; esto exige mejorar sus capacidades de innovación como fuente de desarrollo y estrategia de supervivencia. El objetivo de esta investigación fue determinar qué factores de innovación son más significativos entre la pequeña y mediana empresa (pyme) de la manufactura textil y cómo influyen en su nivel de innovación, tomando como objeto de estudio el sector textil de Tlaxcala, México, considerando los factores de Gary Hamel. La metodología consistió en realizar un diagnóstico sobre la percepción de estos factores a través de un instrumento de medición. Posteriormente, se realizó un análisis de varianza, una prueba Tukey, un análisis de correlación y un análisis de regresión para determinar la significancia y la relación entre las variables. Los resultados revelaron que los factores son significativos en ambos tipos de empresas, además de mostrar una correlación fuerte con su nivel de innovación. Asimismo, se encontró una relación significativa entre el nivel de innovación y los factores analizados, observándose que son determinantes en la mediana empresa, no así en la pequeña. Concluyendo que la pyme requiere implementar la innovación con un enfoque holístico y dinámico considerando los factores propuestos.

Códigos JEL: L67, O30.
Palabras clave: Innovación, Factores de innovación, Pyme.

Introduction

The textile sector, despite its importance in terms of employment, economic units and gross added value, is one of the activities where Mexico trade openness has impacted the most, generating a certain standstill in its development and a reduction of its participation in international trade (Vera & Vera, 2013; Rodríguez & Fernández, 2006). However, its participation in the gross domestic product was of 36,931 and of 38,494 in 2012 and 2014, respectively, observing a growth of 4.23% (INEGI, 2014). Particularly in the state of Tlaxcala, in 2004 there were 106 registered companies, 58 in 2012 (Secretariat of Tourism and Economic Development [SETYDE for its acronym in Spanish], 2014), and 53 companies in 2016, observing a decrease of 50% with respect to 2004 (SEDECO, 2016).

There are different factors that affect the competitiveness of the sector, such as technological delays, lack of quality systems, underutilization of the capacity installed, lack of experience in knowledge management, expensive financing and lack of it, among others (Salgado, Valdés and Camba, 2016; Joya, Gámez, Ortiz, and Gálvez, 2015; Eguiguren, 2013; Ollivier & Thompson, 2009; Rodríguez, 2007; Rodríguez & Fernández 2006; Díaz 1998).

In Mexico, the problematic of the textile industry has worsened, a situation that limits its innovation in the field of fashion. However, the multifunctional role of textiles, ecological textiles, e-textiles and textile personalized products are considered the future of this sector, trends that demand integral changes. On the other hand, the technological advances, the political

and legal changes, and a global market are scenarios that limit its development; therefore, it needs to create strategies to boost its competitiveness, otherwise, its progress will be further affected and its survival will be challenged.

Presently, innovation in SMEs is not part of their functioning, creativity is nonexistent or hindered, and a fashion company that is unable to innovate is sure to fail (Rigby *et al.*, 2009). Therefore, it is important to promote a culture of innovation, not only in the processes and to comply with the needs required by the company at that moment, as is traditionally done (Vera & Vera, 2013; Xelhuantzi, 2008), but also in the products and the organization of work. Because process innovation makes it possible to increase productivity, progressive innovation in products allows differentiation from competitors and opens new markets, and the innovation of the organizational system represents the necessary condition for other forms of innovation to be successful (European Commission [EC], 1995), currently, innovation is a source of competitiveness for companies (Scientific and Technological Advisory Forum [FCCT for its acronym in Spanish], 2012).

Based on the foregoing, this research has the objective of determining the innovation factors that are more significant between small and medium sized textile companies, and how they influence their level of innovation; with textile SMEs in the state of Tlaxcala, Mexico, being the object of study. As research hypothesis, we suggested that the innovation factors are more determinant in the level of innovation in medium than in small sized companies.

Innovation and its factors

Innovation as a strategy for competitiveness

Currently, innovation and research must be considered as drivers for social and economic prosperity, as well as the sustainability of the environment (CE, 2011; Lubin & Esty, 2010; Ríos & Paniagua, 2007; Schermerhorn, 2003). In advanced countries that occupy the first places of the competitiveness ranking, they consider business sophistication and innovation as competitiveness axes (Madrid Business Confederation [CEIM for its acronym in Spanish], n.d.). According to the World Economic Forum, 2016 [WEF], the countries that occupy the first places in the competitiveness ranking consider business sophistication and innovation as competitiveness axes (Sala-i-Martin, 2016). Similarly, the Mexican Institute for Competitiveness [IMCO for its acronym is Spanish] 2010, considers the innovative capacity of companies and the investment in Research and Development (R&D) as competitiveness factors. Comparing the gross domestic expenditure of countries that rank within the first places of competitiveness of the WEF, it was identified that they allocate between 1.7% and 3.5% of their budget in R&D, which means that they make a greater effort concerning research, since they consider it a determinant factor to innovate and achieve high levels of competitiveness. Meanwhile in Mexico, only 0.4% of the gross domestic expenditure is allocated (World Bank, 2014) and is, generally, allocated to other aspects in the event of fluctuations in the economy, which is reflected on several business sophistication and innovation levels. According to Sala-i-Martin (2016), pressure to cut R&D expenses must be fought in order to drive a sustainable development. In this sense, González (2005) establishes that the levels of financing are limited, but it is possible to multiply the resources if the groups and sectors unite on a common goal.

In recent years, companies have been considered an important cause for social, environmental and economic problems (Porter & Kramer, 2011). And in the face of sociopolitical and economic fluctuations, the emergence of conflict and crisis in companies

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is favored (Schlemenson, 2013) and is, therefore, necessary to promote in SMEs a culture of knowledge that is sustained in innovation. Companies innovate every time they invent, develop and apply new products, programs or administration styles (Manual de Oslo, 2007; Porter & Kramer, 2011). Three types of innovation can be distinguished: products, processes, and organizational. Product innovation comprises the introduction of a new good or one that has had its characteristics or possible uses significantly improved; process innovation is the introduction of a new or significantly improved method; and organizational innovation is introducing a new method applied to business practices, to the organization of work or to the external relations of the company (Schermerhorn, 2003; Manual Oslo, 2007; Herrscher, Rébori & D´Annunzio, 2009; Samaniego, 2010; National Council for Science and Technology [CONACYT], 2016). Innovation entails radical or gradual changes; the former involves the restoration of the company, whereas the gradual changes are at a micro level, for example, technical improvements in a product, procedure or system (George & Álvarez, 2005).

Innovation can happen in five different levels: low, medium low, medium, medium high, and high (Gianella, 2009). The low level entails incorporating technology developed by third parties in order to replace natural processes, there is no innovation in products and procedures beyond what is provided by the incorporation of technology; medium low entails incorporating technology developed by third parties to replace processes that already possessed a certain degree of technology; the medium level entails the incorporation and modification of technology to adapt it to the procedures, allowing the modification of processes according to the impact and possibilities provided by the technology; medium high entails producing R&D to achieve a specific innovation, where the capacity to adapt technology and processes can be by the own company or through third parties and it impacts one or more areas, generating new products and processes; the high level entails the application of R&D, creating new products and generating an improvement effect that is reflected throughout the company, having the capacity to adapt the technology and processes. It is worth noting that in this era, innovation and technology have a great impact on both the industry and society (Saavedra & Jiménez, 2014), therefore, it is important to promote a sector characterized by a strong desire for innovation and a vision of the future (González, 2005).

Innovation factors

Over the years, different models for innovation have been proposed. For example, the linear innovation models involve a progressive step by step approach and consider R&D as a catalyst for innovation (Velazco, Zamanillo and Gurutze, 2005). The chain-linked model by Kline (1985), shows the complexity implied in the research-development-innovation process, as well as in the relation between innovation and R&D (Velazco et al., 2005). In the network innovation model, it is established that innovation is a know-how accumulation process that involves internal and external learning elements and thus is a network process (Hobday, 2005, cited in Velazco et al., 2005). In the wheel of innovation by Hamel (2004), it is indicated that in order to prosper in this era, companies must adopt a new radical innovation agenda, considering four components: skills, information technology, measurement and management process, establishing that the innovative dynamic of the companies will depend on the attention given to the same. In the national innovation capacity model by Furman, Porter and Sterm (2002), it is proposed that the innovative capacity of a country depends on technological sophistication and on labor, investments and the policies of the state and private sectors, as well as on the incentives

for R&D. In the triple helix concept, it is indicated that the interface in which innovation systems operate is comprised by the meeting point between the subsystems of the academy, the industries based on knowledge and the governments (González de la Fe, 2009; Chang, 2010). This analysis allowed identifying that, for the most part, the models detail a methodology to carry out innovation considering only technology, knowledge and the market as the main pillars, attributing a small relevance to other types of factors. Therefore, this research considered the Wheel of Innovation by Hamel (2004), as it considers the aforementioned factors and integrates the measurement and management processes to consider them holistically and as pillars, given that each one plays a vital role in the creation of a capacity for innovation in the business sector.

The skills factor establishes that the skills of the personnel must be permanently reconfigured, and a systematic and multidisciplinary training must be promoted in order to incorporate innovation as a capacity. The measurement factor determines how to evaluate the capacity to invent business concepts. Nevertheless, indicators that focus on the costs, efficiency, speed and customer satisfaction are currently still applied, and workers are paid based on these metrics. With regard to information technologies, it explains that it is through networks that tools for innovation are found. Digital communication makes it possible to collaborate worldwide, bringing together supply chains that are far from each other and allows the existence of technical services. Unfortunately, only few have used this factor to promote innovation, involving their entire personnel. Regarding management processes, it indicates that companies that have undergone reengineering in their key processes to achieve efficiency, will have to reinvent their key processes to achieve innovation. The traditional management processes strengthen conformism, alignment and continuity, so these should be less backward and more innovative (Hamel, 2004).

The indicators studied in the factors were identified considering the criteria of the aforementioned innovation models, as well as the different competitiveness systems that considered innovation as determinant. These are described below.

Porter (2007) establishes that the competitiveness of a nation depends on the capacity of its industry to innovate, and considers four qualities in his model "The competitiveness advantage of nations". In the first—conditions of the factors—he establishes that the position of the nation with respect to factors such as skilled labor or infrastructure is necessary to compete. In the second—conditions of the demand—he states that the nations obtain a competitive advantage in industries where the local demand provides their companies with a clearer or earlier vision of the emerging needs of buyers, and where demanding buyers put pressure to innovate and achieve competitive advantages. In the third, the presence of related and supporting industries that are internationally competitive is considered necessary, as the local suppliers that are internationally competitive create advantages in the secondary industry when delivering the most economic inputs in an efficient, timely and sometimes preferential manner, and the companies have the opportunity of influencing the technical efforts of their suppliers and can act as test sites for R&D, accelerating innovation. In the fourth strategy—structure and rivalry of the firms—he describes that the context creates trends regarding how companies are created and managed, and what will be the nature of the domestic rivalry.

The WEF (2016) considers the innovation and sophistication factors as pillars of competitiveness. Concerning business sophistication, it evaluates the quantity and quality of local suppliers, the development of clusters, the nature of their competitive advantage, value chain, control of the international distributions, sophistication of the production processes,

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commercialization and willingness to delegate authority; and concerning innovation, it measures the capacity to innovate, quality of the research in institutions, expenses on R&D, collaboration between universities and the industry in R&D, support of the government to acquire advanced technology, availability of scientists and the use of patents (Sala-i-Martin, 2016).

IMCO (2010) considers ten competitiveness factors, the ones related to innovation are: sustainable management of the environment, by the indicator of companies certified as clean; efficient factor markets, by the indicator of population with medium high and higher education; and economic sectors in strict competition, by the indicators of positions in big and medium sized companies, certified companies and R&D expenditure.

It is worth noting that in the past, the relations between the industry and its environment had unsurprising characteristics, the changes were infrequent and they had a low incidence in management or were predictable. However, changes are more frequent nowadays, they have more of an influence on companies and are hard to predict (Rodríguez, 2005). In this century, companies must commit with their product from its conception until after its useful life (Bateman and Snell, 2005), creating products that are easy to restore, reuse or recycle, using environmentally appropriate technologies, with an environmentally friendly package, reducing contamination to a minimum, renovating natural resources, stimulating the conservation of energy, the use of fewer resources, and promoting the development of green jobs (Bateman and Snell, 2005; Bradbrook, S., Duckworth, M., & Ellwood, P., 2013).

These trends in the medium term will demand new business practices such as "pollution prevention, product care, investment in clean technologies and a vision of sustainability" (Lorea, 2008, p. 26), thus companies need to integrate themselves to innovation processes with an ecological approach, that is, eco-innovation; understood as any type of innovation that creates business opportunities and benefits the environment, preventing or reducing their impact or optimizing the use of resources (CE, 2013). In this new dynamic, innovation in SMEs is positioned as a strategic activity for competitiveness not only at a national level, but also internationally speaking (Chiavenato, 2010; Armenteros, Reyna, Rodríguez & González, 2014).

Methodological strategy

A mixed research was carried out in this study, which implies a linkage and analysis process for quantitative and qualitative information in order to respond to a problem, but with a quantitative preponderance (Hernández, Fernández and Baptista, 2014). The scope was exploratory, descriptive, correlational and explanatory, as the current situation of the variables was identified in a scarcely researched sector. The information was collected and measured independently for each variable, analyzing the existence of correlations between them, and we sought to explain these results based on an inferential analysis. The design was of the non-experimental and transversal type (Hernández *et al.*, 2014). The variables being studied were the innovation factors and the level of innovation. Based on the theory, the indicators were proposed for the first variable taking as reference the factors of the Wheel of Innovation by Hamel (2004). For the second variable, the dimensions analyzed were the level of product, process, and organizational innovation, analyzing the indicators of new products and improved products, new processes and improved processes, as well as the organizational redesign and its impact that on the company. The dimensions and indicators of the second variable were proposed considering the criteria of Samaniego (2010); Herrscher, Rébori & D´Annunzio (2009); CONACYT (2016); Manual Oslo (2007); and Schermerhorn (2003). The research

focused on the textile SMEs of Mexico, due to their participation in the national economy, the number of economic units that they represent, and the number of jobs that they create. We considered the SME of the state of Tlaxcala as the object of study, for its representativeness in the business structure of the entity (SEDECO, 2016) and for being considered one of the seven high ranking states in the textile industry in Mexico (Bigio, 2015).

The measurement instrument of 81 reagents was designed considering mainly the innovation criteria by Hamel (2004), by Furman, Porter and Sterm (2002), by Porter (2007), by WEF (2016) and by IMCO (2010). It was divided into two parts, in the first the factors were analyzed with 59 reagents, and in the second the level of innovation was measured with 22 reagents. For the measurement of each item the interval metric scale was applied.

For the qualitative analysis, the internal environment of the companies was observed, and the general director and/or manager of the plant was interviewed. For the quantitative analysis, the Likert scaling method criteria was applied, considering five categories in each item (Hernández *et al*., 2014), assigning values from one to five. To establish the level of determination of the innovation factors variable, the criterion applied in the Competitiveness Ranking of the WEF and IMCO was applied, where 1 is specified as definitively determinant, 2 very determinant, 3 determinant, 4 not very determinant and 5 not determinant. In the second variable, the criterion by Gianella (2009) was used, where the levels of innovation are measured with the values: 1 high, 2 medium high, 3 medium, 4 medium low and 5 low.

The instrument was validated through the judgment of experts and its reliability was calculated using Cronbach's Alpha. It was applied to the general director and/or plant manager of the textile SMEs in the state of Tlaxcala. According to data from the SETYDE (2015), the entity has 30 small textile companies and 25 medium-sized companies, from which 50% (15) of the small and 60% (15) of the medium sized companies agreed to collaborate with the research, which represented 55% (30) of the total population. Two are located in the state capital and the others are distributed among the municipalities of Apetatitlán de Antonio Carvajal (5), Chiautempan (8), Contra de Juan Cuamatzi (4), La Magdalena Tlatelulco (2), Papalotla de Xicohténcatl (2), San Pablo del Monte (1), Santa Isabel Xiloxoxtla (3) and Zacatelco (3).

To establish the significant differences in the level of determination of the innovation factors analyzed between the small and medium sized companies of the textile sector, as well as between the level of innovation of the SME, a variance analysis was applied (ANOVA) for a complete model of random blocks (Montgomery, 2014). Subsequently, a Tukey test was applied to carry out multiple comparisons with a significance level of $p<0.05$. The results were analyzed using the statistical program Minitab 16®.

To determine the influence of the factors on the level of innovation of the SMEs, a Pearson's correlation analysis (r) was carried out with a significance level of $p<0.05$, presenting the results based on Roundtree's criterion, shown in Table 1 (De Muth, 2014).

Table 1
Rountree correlation criterion between two variables.

R value	Correlation type and degree
<0.20	Very weak, ineligible
0.20-0.40	Weak, low
0.40-0.70	Moderate
0.70-0.90	Strong, high
>0.90	Very strong, very high

Source: De Muth, (2014).

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The linear regression analysis was done based on the correlation results, taking as dependent variable the level of innovation by size of the company, and each of the analyzed factors as predictor variable.

Finally, to explain the reason behind the quantitative results obtained, we also resorted to the qualitative approach, which allowed determining and describing the differences between small and medium sized companies.

Comparative analysis of innovation factors

Based on the theoretical analysis, the indicators shown in Table 2 are proposed for the innovation factors variable. Each indicator is defined to identify its relationship with the innovation factors of Hamel (2004).

Table 2
Innovation factors and indicators

Innovation factor	Indicator	Definition
Skills	Education	Comprises learning and training (Hellriegel & Slocum, 2009). The quantity and quality of the education received increases efficiency. A limited education is an obstacle for innovation (WEF, 2016).
	Organizational learning	Its aim is to develop knowledge and skills in people so that they act efficiently. It must be organized, continuous and involve all workers. This process leads to creativity and innovation (Hernández, 2006).
Measurement	Measurement of the performance	It is a means to assess the employee, develop skills, reinforce performance and distribute rewards (Fletcher, 2001). It is strategic (Vázquez, 2007). It must be systematic and monitored (Ahmed, Shepherd, Ramos, L. & Ramos, C., 2012).
	Management system and quality assurance	Planned and systematic actions to bestow confidence on a product or service or satisfy the demands of the client (Álvarez, J., Álvarez, I. & Bullón, 2006).
	Monitoring of competitors	It is "visualizing the competitors that could be a threat, and those that can strengthen the competitive position and not only weaken it" (Porter, 2007, p. 203).
Information technology	Digital communication media	They are mediators of communication and introduce novelties because they incorporate new technological dimensions, combine dimensions of interpersonal communication and mass means of communication, induce change and new forms of time management (Cardoso, 2010).
Management processes	Information systems	A group of people, data and procedures that work together to save, process and disseminate information for decision making and control purposes (Chiavenato, 2006).
	Relation between academia and the productive sector	It is the collaboration between higher education, research centers and the productive sector. Its aim, for higher education institutions, is to advance in scientific and academic development; and for the productive sector, the technological development and the solution of problems (FCCT, 2012).
	Modern manufacturing systems	Are integrated production processes, with advanced machinery and material handling systems (Groover, 2011).
	Patents	Modality of the industrial property that protects the right of invention granting a right of exclusive exploitation of the same in a territory, an application or use and for a certain period of time (World Intellectual Property Organization [WIPO], 2015). Method that the governments use to motivate innovators; they protect innovation against copies made by the competition (Ahmed, Shepherd, Ramos, L. & Ramos, C., 2012).
	Clusters	Geographic concentrations of interconnected companies, specialized suppliers, service providers, companies of related sectors and related institutions that compete but that also collaborate. In a cluster, the entire group supports each other (Porter, 2003).
	Perception of innovation	Is identifying how determinant the concept of innovation is for the directors of companies, to identify whether it is favored and dynamized in the same (Sanz, & Velasco, 2014).

Research and development	It is the systematic creative work to increase knowledge and the use of this knowledge to derive new applications. Comprises the basic, applied and experimental development research (Spanish Foundation for Science and Technology, [FECYT for its acronym in Spanish], 2002).
Planning	It is determining the objectives in advance and the necessary activities to achieve them. Its function was to reduce the uncertainty regarding the future and the environment; currently, it is to accept uncertainty as is presented, looking to challenge uncertainty with creativity and innovation (Chiavenato, 2006).
Target Market	Departs from the selected market to offer goods (Sulser & Pedroza, 2004). The international markets are a substitute of the internal markets (WEF, 2016).

Source: Own elaboration.

Regarding the reliability of the measurement instruments, this resulted in a value of 0.976, which indicates a high reliability (Hernández, Fernández and Baptista, 2014).

The result obtained from the ANOVA analysis for small companies is presented in Table 3, where it can be observed that the p value is greater than 0.05 (0.119) demonstrating that there are no significant differences between the means of the factors, since they are not considered important.

Table 3
ANOVA for the innovation factors in small companies

Source of variation	Sum of the squares	Level of freedom	Mean square	*F*	*P*-value
Innovation factors	8.08	3	2.692	1.96	0.119
Error	1212.32	881	1.376		
Total	1220.4	884			

Source: Own elaboration based on the results obtained in Minitab 16®

To confirm this analysis the Tukey test was applied, the results of which are shown in Table 4. These results show that there are no significant differences ($p<0.05$) between the means of the factors, since all of them are perceived with a trend towards not very determinant. Since comfort and continuity of activities prevail in the management process, they show no interest in the training of the personnel, activities are evaluated occasionally and informally, and the media are limited and obsolete. A traditionalist culture is observed, where innovation is perceived as a complex process that also entails a big drain on resources.

Table 4
Tukey test for innovation factors in small companies

Factor	Level of determination[1]
Management processes	3.87 ± 0.10 a
Skills	3.78 ± 0.17 a
Measurement	3.64 ± 0.24 a
Information technology	3.59 ± 0.27 a

[1] The values with the same letters did not show significant differences ($p < 0.05$)
Source: Own elaboration based on the results obtained in Minitab 16®

For the medium sized companies, the ANOVA analysis result showed significant differences given $p<0.05$ (0.000), which demonstrates that at least one mean of the innovation factors is different; this means that the analyzed factors are considered important for their competitiveness.

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Table 5
ANOVA for innovation factors in medium sized companies

Source of variation	Sum of the squares	Level of freedom	Mean square	*F*	*P*-value
Innovation factors	31.51	3	10.502	6.45	0.000
Error	1434.75	881	1.629		
Total	1466.25	884			

Source: Own elaboration based on the results obtained in Minitab 16®

Similarly, Table 6 shows the results of the Tukey test for the innovation factors of medium sized companies.

Table 6
Tukey test for the innovation factors in the medium sized companies

Factor	Level of determination[1]
Skills	3.53 ± 0.18 a
Management processes	3.53 ± 0.11 a
Measurement	3.19 ± 0.26 a,b
Information technology	2.92 ± 0.29 b

[1] The values with the same letters did not show significant differences ($p < 0.05$)
Source: Own elaboration based on the results obtained in Minitab 16®

The presence of significant differences ($p<0.05$) can be observed between the means of the factors, with information technologies standing out, represented by the letter b, with a determinant trend (2.92); therefore, it is emphasized that medium sized companies consider information technologies important in their management process. Comparing the results of the media analyzed in this factor it can be observed that telephone, fax, internet and websites are perceived as determinant for their competitiveness. It is also important to indicate that the intranet and extranet systems with an average mean of 4.6 are not considered determinant at all due to them not being known, and to the fact that their information systems are not complete and integral, a situation that affects objectivity and the quality of their decision-making process.

Regarding the skills factor, represented by the letter a, it presented a significant difference ($p<0.05$), with a mean of 3.53 so it is considered as having a trend towards not very determinant. Comparing the measures of the indicators of this factor, regarding education it can be observed that the level of education of the directives is perceived as very determinant (2.27), while those of the owner (3.13) and of the middle-ranking officials (3.2) is determinant, whereas that of the operating personnel is not very determinant (4.13). In the organizational learning indicator, the training received by the directives and middle-ranking officials is perceived as a trend towards not very determinant (3.53), and the one received by the owner (3.7) and the operating personnel (4.07) is not very determinant. In this situation, it is worth noting that for companies to be innovative and flexible it is necessary that their management models allow the development of cognitive skills (Calori, 1998 cited in Torres and Mejía, 2006), as this will facilitate the transfer of knowledge and will allow the formation of collaborators who will not only make routine and adaptation decisions, but also innovative ones.

With regard to the management processes factor, represented by the letter *a*, it presented a significant difference ($p<0.05$) with a mean of 3.53, which means that it is also perceived to have a not very determinant trend. Comparing the arithmetic measures of the indicators analyzed in this information systems factor, relation between academia and the productive

sector, modern manufacturing systems, clusters, patents, research and development, planning and target market, it is observed that medium-sized companies lack systemic and integral information systems for decision-making, and thus resort mainly to information related to sales. Regarding the relation of academia and the productive sector, it was identified that it does not have a research relationship with academia (5.00) and very rarely does it establish collaboration agreements with these (4.20), and then only for the development of social services and internships, and in some of them to carry out business visits. Finally, from its manufacturing systems, the age of their machinery is considered not very determinant (3.80).

Regarding the clusters indicator, it was identified that the relations with other companies are considered very determinant (2.20) and the relations with the Textile Chamber and with the Ministry of Labor and Social Security are considered determinant (3.20). Nevertheless, the relation with government organizations is not very determinant (4.31), because when they have requested some support this has been inadequate due to the procedures that it implies. Similarly, their relationship with organizations related to the environment is not very determinant (3.70), presenting a weak culture with regard to environmental care.

Concerning the patents indicator, medium sized companies consider it not very determinant (4.47). However, it is currently a requirement to protect their products and it is an indicator of quality (Ahmed, Shepherd, Ramos, L. & Ramos, C., 2012). This is due to the fact that 93.3% of companies cater only to a national market and most of them depend on having a client as intermediator. From the research indicator, they consider their capacity as medium low (4.13) resulting in a medium low level of innovation (4.20).

In the planning indicator, the participation of the directives is very determinant (2.27), that of middle-ranking officials is determinant with a trend towards not very determinant (3.27), and that of the operating personnel is not very determinant (4.13). However, according to Franklin and Krieger (2011), leadership should currently involve people with different points of view and perspectives for a more complete image of the company and its opportunities. Therefore, the learning of skills for work should be promoted, which will influence decision quality. It also rarely invests on R&D (4.07), it does not have a budget to control pollution (4.27), environmental policies are limited or nonexistent (4.00), and there is a lack of measures for the control of products after their useful life (5.00).

According to the results from the Tukey test in Table 7, the perception of the factors between small and medium-sized companies is analyzed to identify their differences.

Table 7
Perception of the innovation factors by company size

	Company	
Factor	**Small**	**Mediana**
Management processes	Not very determinant	Tendency towards not very determinant
Skills	Not very determinant	Tendency towards not very determinant
Measurement	Tendency towards not very determinant	Determinant
Information technology	Tendency towards not very determinant	Determinant

Source: Own elaboration based on the results obtained in SPSS 21®

In the above table, it can be observed that the factors influence the functioning of the companies. Regarding the process management factor, small companies consider it not very determinant and medium-sized companies show a trend towards the same. This is due to the fact that both types of companies give little interest to the relation between academic and

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research institutions, for fear of their systems being replicated; they do not consider it relevant to patent their products because they perceive it as a complex process, and due to their lack of economic capacity to modernize their machinery and the limited technological capacity to create information systems to support the decision-making processes. However, it stands out that medium-sized companies show interest in the implementation of R&D due to the fiscal benefits they may obtain from it, although they do not know how to go about it. Regarding alliances, the two types of companies prefer establishing relationships only with companies in the country, but not with governmental organizations due to how complicated the procedures are. This is consistent with the results by Martínez, Vera and Vera (2013), where they establish that the governmental procedures are an obstacle to innovation. However, Porter (2007) states that for national competitiveness the government is a determinant factor, given that the industry currently faces a dynamic and unpredictable environment.

Regarding the skills factor, small companies consider it not very determinant, whereas medium-sized companies show a trend towards not very determinant. It can be observed that medium-sized companies give more importance to the education level of their directives. Furthermore, they only show interest in the training of directives and middle-ranking officials. Meanwhile, small companies do show interest in the education level of their directive personnel, but they do not consider the training of the entire personnel as being determinant. Nevertheless, both coincide in that the education level of the operating personnel is not relevant; therefore, they do not care to improve the education level of the personnel that already works there, and when they hire new personnel they do not care for the education level of the candidates, considering that it is enough for them to know the basic mathematical operations. Furthermore, they lack a diagnosis process to identify their real needs in learning and thus manage the appropriate training that will truly improve the labor skills of the workers. All of this represents a limitation for the transfer of knowledge and for the innovation of the SMEs. In both types of companies an inventory of labor skills must be systematically done in order to promote a systematic and multidisciplinary training in all of the personnel. It is worth noting that the level of education of the personnel, regardless of their hierarchy, does impact the efficiency and competitiveness of the analyzed companies, and as mentioned by Hamel (2004) and Sala-i-Martin (2016), currently, a limited education is an obstacle for innovation. Additionally, the technological revolution compels the replacement of disciplinary, routine and alienating work for flexible, multipurpose and creative work based on knowledge (Barba, 2000).

Regarding the measurement factor, this is perceived as a determinant in medium-sized companies due to considering it necessary to evaluate the operating personnel and middle-ranking officials to improve their performance, implement quality systems to improve their productivity, and to permanently evaluate the competition to identify improvements. Conversely, in small companies this factor is perceived as not very determinant. No interest is shown in the evaluation and quality systems, and they do not care to analyze the competition, as they are used to working and remaining in the market in this manner. This passive behavior represents a risk in a context where change is constant and where it has become imperative, considering the capacity to invent business concepts as a measurement indicator (Franklin, 2013). It is clear that both types of companies require technical support to implement an integral and permanent evaluation system, so that evaluation criteria are applied in a planned manner to measure the innovative capacity of companies and as a strategy to generate integral changes or improvements where the entire personnel participate.

Concerning the information technologies factor, the medium sized companies perceive it as determinant because they consider that it is necessary to have a website nowadays to promote the company and maintain fast, continuous and low-cost communication with clients and other groups of interest; as well as to have internet for the directives and middle-ranking officials in order for them to access updated information. While small companies prioritize the access to internet this is only at the directive level, as well as the use of the telephone line, which is considered a disseminator of the old technologies (according to Chinaprayoon, 2007, cited in Pérez, Lara and Gómez, 2017). It stands out that in both companies, technical orientation is required to integrate contemporary digital means of communication to their management, such as the internet, intranet and extranet systems, as they are currently indispensable resources to maintain communication and share timely information between all the areas of the company, as well as with clients, suppliers and other companies, mainly. This will result in a higher individual performance and in an improvement of the organizational results (Abrego, Sánchez and Medina, 2016).

For the innovation level variable, the results of the ANOVA analysis revealed that between small and medium-sized companies there are no significant differences in the innovation of products ($p = 0.107$). However, regarding process and organizational innovation there were significant differences with $p = 0.000$ and $p = 0.007$, respectively, which derived in the existence of a significant difference between their level of innovation ($p = 0.000$) as shown in the results of the Tukey test in Table 8.

Table 8
Tukey test for the level of innovation in small and medium-sized companies

Company	Level of innovation	Product innovation[1]	Process innovation[1]	Organizational innovation[1]
Small	4.26 ± 0.09 a	4.20 ± 0.17 a	4.25 ± 0.14 a	4.33 ± 0.16 a
Medium	3.93 ± 0.09b	4.00 ± 0.17 a	3.85 ± 0.14 b	4.01 ± 0.16 b

[1] The values with the same letters did not show significant differences ($p < 0.05$)
Source: Own elaboration based on the results obtained in Minitab 16®

In product innovation, it was found that medium-sized companies presented a mean of 4.0, which places them on a medium low level and small companies presented a mean of 4.20 with a trend towards the same level; as such, they do not present significant differences statistically speaking. Due to the fact that both types of company, in addition to lacking a vision that will prompt them to create new products, they also implement little improvements in existing products, due to the fact that they do not have the labor skills to do so and that their machinery, equipment and technological resources are not updated and are insufficient. They also consider that they require time, investment and it implies a high risk, preferring to work with what they already know.

Regarding process innovation, the presence of significant differences ($p<0.05$) can be observed among the measures, where it was found that the medium-sized companies, represented by the letter *b*, presented a mean of 3.85 which placed it on a level with a medium low trend, and small companies, represented by the letter *a*, had a mean of 4.25 with a trend towards a low level. This is due to the fact that the medium-sized companies regularly implement improvements in the processes and are concerned with developing skills, mainly, in the directive personnel. They have also incorporated machinery, equipment and/or technology,

they have modified their processes, and have even allowed the replacement of some of them for new processes. Meanwhile, small companies show no interest in improving their processes or incorporate new ones because they do not have the human capital and the necessary resources. Furthermore, they consider that it demands time and resources, and that it is difficult to do.

Regarding organizational innovation, the presence of significant differences ($p<0.05$) can also be observed among the measures, identifying that medium-sized companies, represented by the letter *b*, presented a mean of 4.01 which placed them on a medium low level, and small companies, represented by the letter *a*, presented a mean of 4.33 with a trend towards a low level. This is due to the fact that in medium-sized companies there is an interest in making changes to their organizational systems and in adapting new technologies, methods and/or specialized software. Conversely, small companies show apathy towards organizational changes, due to the fact that they do not perceive it important since they are more focused on production and do not have the resources to do it. However, the modernization and flexibilization of the administrative structure of companies are vital requirements to adapt to the more aggressive contexts and to sectors of the market that are more dynamic and demanding. Furthermore, the flexible or organic organization models allow developing standards and values that emphasize competition, as well as the capacity to act in an innovative manner (Nava, 2013; Franklin and Kriger, 2011; Chiavenato, 2010; Barba, 2000).

These results demonstrate the existence of significant differences in the level of innovation, observing a medium level in medium-sized companies (3.93) and a trend towards low in the small companies (4.26). This demonstrates that the factors are more determinant for the medium sized companies.

Subsequently, Table 9 shows the results obtained from the Pearson correlation analysis among the factors and the level of innovation of small and medium-sized companies.

Table 9
Pearson's correlation (r) for small and medium-sized companies

Innovation factors	Correlation with the level of innovation	Level of significance	Degree of correlation
Small company			
Skills	0.824**	0.000	Strong, high
Measurement	0.718**	0.003	Strong, high
Management processes	0.871**	0.000	Strong, high
Information technology	0.867**	0.000	Strong, high
Medium sized company			
Skills	0.654**	0.008	Moderate
Measurement	0.825**	0.000	Strong, high
Management processes	0.809**	0.000	Strong, high
Information technology	0.692**	0.004	Moderate

** The correlation is significant at the 0.01 (bilateral) level.
Source: Own elaboration based on the results obtained in SPSS 21®

The Pearson analysis reveals that in order for small companies to increase their level of innovation they must work on the four factors of innovation, as the existence of significant correlations ($p<0.05$) was identified. Management processes stands out as the factor that showed a greater correlation (0.871) with a significance lower than 0.01; this due to the importance that must be placed on research and development, planning, alliances or the formation of clusters, and on the information systems. From the information technologies factor (0.867), the strengthening of digital media stands out, as well as a better access to internet and the creation

of websites. From the skills factor (0.824), the organizational learning at all levels and the measurement factor to monitor competitors should be noted.

With regard to medium-sized companies, the Pearson analysis shows that in order to increase the level of innovation they ought to prioritize the measurement factors and the management processes, and since the former showed a greater correlation with the level of innovation (0.825), given that they must strengthen or implement the management and quality assurance systems. Similarly, the management processes factor also presented a strong correlation (0.809), due to the importance that they ought to place on modern manufacturing systems, the target market, R&D, the relation between academia and industry, and on patents and planning. It stands out that the information technologies and skills factors showed moderate significant correlations, due to the fact that most have basic means of communication (internet and websites), and additionally consider the education and training of their directive personnel.

Based on the correlation analysis, Table 10 shows the results of the regression model between the level of innovation of the small and medium-sized companies with the skills factor.

Table 10
Linear regression model between the level of innovation and skills

Company	Dependent variable	Predictor variable	Non-standardized cofficient B	Typified Beta coefficient	t	Sig.
Small (SE)	SE innovation level	Skills	0.720	0.824	5.251	0.000
		Constant	1.540		2.959	0.011
Medium (ME)	ME innovation level	Skills	0.926	0.654	3.114	0.008
		Constant	0.660		0.619	0.547

Source: Own elaboration based on the results obtained in SPSS 21®

The results reveal that the skills factor significantly influences the two regression models ($p<0.05$). Furthermore, the typified Beta coefficients show that the predictor variable explains the dependent variable (82.4% in the level of innovation of small companies and 65.4% in medium-sized companies).

Finally, the regression equations between the level of innovation and skills in small and medium-sized companies are the following:

$$\text{SE level of innovation} = 1.540 + 0.720\ \text{Skills} \quad (1)$$
$$\text{ME level innovation} = 0.660 + 0.926\ \text{Skills} \quad (2)$$

The graph shown in Figure 1 is obtained from equations 1 and 2.

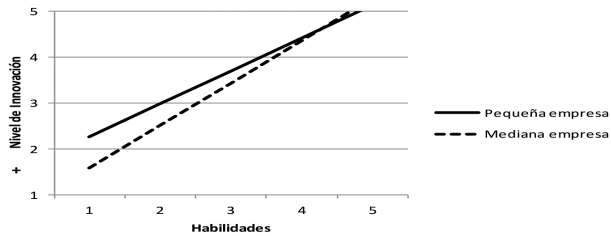

Figure. 1. Linear regression model between the level of innovation and skills
Source: Own elaboration based on the results obtained in SPSS 21®

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Figure 1 shows that with more determinant skills (trend towards 1), a greater level of innovation is obtained (trend towards 1). Additionally, for the same value in the perception of the skills, the trend of the level of innovation is one level above in medium-sized companies with respect to small ones. This is due to the fact that according to the ANOVA analysis results, the perception of this factor by both types of companies is very similar (between determinant and not very determinant).

With respect to the levels of innovation and the measurement factor, the results of the regression analysis were the following (see Table 11).

Table 11
Linear regression model between the level of innovation and measurement

Company	Dependent variable	Predictor variable	Non-standardized coefficient B	Typified Beta Coefficient	t	Sig.
Small (SE)	SE level of innovation	Measurement	0.421	0.718	3.723	0.003
		Constant	2.727		6.548	0.000
Medium (ME)	ME level of innovation	Measurement	0.734	0.825	5.265	0.000
		Constant	1.594		3.438	0.004

Fuente: Elaboración propia con base en los resultados obtenidos en SPSS 21®

It can be observed that the measurement variable significantly influences the regression models ($p<0.05$) with a Beta coefficient of 0.718 (71.8%) for the level of innovation in small companies and of 0.825 (82.5%) in medium-sized companies, which also shows that it significantly influences the regression equation.

The regression equations between the level of innovation and measurement in small and medium-sized companies are the following:

$$\text{SE level of innovation} = 2.727 + 0.421\ \text{Measurement} \quad (3)$$
$$\text{ME level of innovation} = 1.594 + 0.734\ \text{Measurement} \quad (4)$$

The graph shown in Figure 2 is obtained from equations 3 and 4.

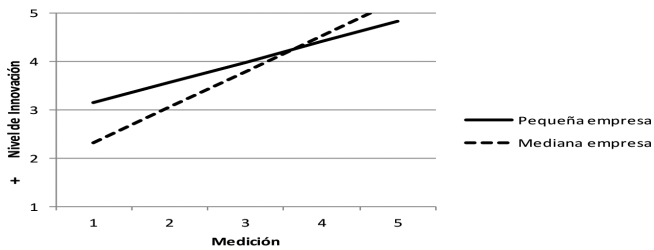

Figure. 2. Linear regression model between the level of innovation and measurement
Source: Own elaboration based on the results obtained in SPSS 21®

Figure 2 shows that the more determinant the measurement factor (trend towards 1), the higher the level of innovation (trend towards 1). However, if the measurement is considered determinant (3) in medium-sized companies, the level of innovation is higher than in small

companies, but if it is considered not very or not determinant (4 or 5) the level of innovation will be lower with respect to the small companies. This situation is reflected on the ANOVA analysis in the perception that medium-sized companies have on measurement (determinant) compared to small companies (not very determinant).

Regarding the regression analysis between the level of innovation and the management processes factor, the results are the ones shown in Table 12.

Tabla 12
Modelo de regresión lineal entre el nivel de innovación y procesos de gestión

Company	Dependent variable	Predictor variable	Non-standardized coefficient B	Typified Beta coefficient	t	Sig.
Small (SE)	SE level of innovation	Management processes	0.733	0.871	6.386	0.000
		Constant	1.427		3.201	0.007
Medium (ME)	ME level of innovation	Management processes	1.263	0.809	4.968	0.000
		Constant	-0.519		-0.572	0.577

Source: Own elaboration based on the results obtained in SPSS 21®

Where the management processes also significantly influence the regression models ($p<0.05$) and with Beta coefficients of 0.871 (87.1%) and 0.809 (80.9%) in the innovation levels of small and medium-sized companies, respectively.

Similarly, from Table 12 the corresponding regression equations are obtained, these being:

SE level of innovation = 1.427 + 0.733 Management processes (5)
ME level of innovation = -0.519 + 1.263 Management processes (6)

The graph shown in Figure 3 is obtained from equations 5 and 6.

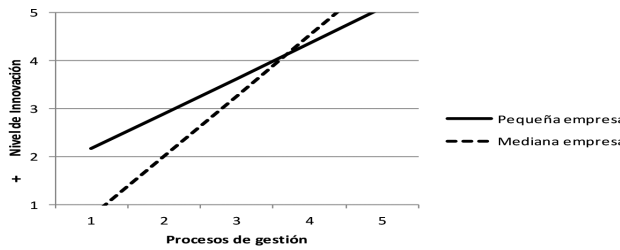

Figure. 3. Linear regression model between the level of innovation and the management processes
Source: Own elaboration based on the results obtained in SPSS 21®

Figure 3 shows a similar behavior to the measurement factor. Nevertheless, in order for medium-sized companies to have a high level of innovation (trend towards 1) and a medium high level (trend towards 2) for small companies, the management processes ought to be considered determinant (1 or 2). This is due to the fact that the ANOVA analysis revealed that this factor is not transcendental for both types of companies in their innovation processes.

Table 13 shows the results of the regression models between the level of innovation and the information technologies factor.

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Table 13
Linear regression model between the level of innovation and information technology

Company	Dependent variable	Predictor variable	Non-standardized coefficient B	Typified Beta coefficient	t	Sig.
Small (SE)	SE level of innovation	Information technology	0.398	0.867	6.285	0.000
		Constant	2.834		12.253	0.000
Medium (ME)	ME level of innovation	Information technology	1.174	0.692	3.459	0.004
		Constant	0.588		0.599	0.560

Source: Own elaboration based on the results obtained in SPSS 21®

The results show that information technologies significantly influence the regression models ($p<0.05$) and that their Beta coefficients explain the dependent variable, with 0.867 (86.7%) in small companies and 0.692 (69.2%) in medium-sized companies.

The regression equations between the level of innovation and information technology are the following:

$$\text{SE level of innovation} = 2.834 + 0.398 \text{ Information technology} \quad (7)$$

$$\text{ME level of innovation} = 0.588 + 1.174 \text{ Information technology} \quad (8)$$

The graph shown in Figure4 is obtained from equations 7 and 8.

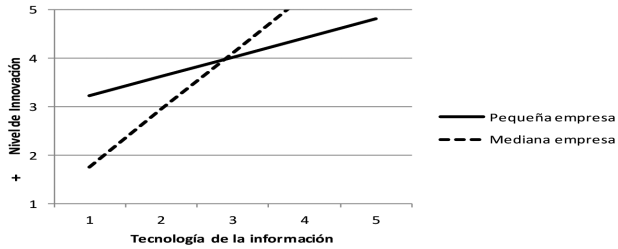

Figure. 4. Linear regression model between the level of innovation and information technology.
Source: Own elaboration based on the results obtained in SPSS 21®

Figure 4 shows that the more determinant (trend towards 1) the information technologies, the greater the level of innovation (trend towards 1) is obtained. However, it can be observed that for most cases concerning small companies, the level of innovation is perceived with a medium low trend (trend towards 4). Whereas in medium-sized companies, when the information technologies are more determinant, this results in a medium and medium high level of innovation (trend between 2 and 3). This is mainly due to the fact that in small companies this factor is perceived as not very determinant (4), and this is not the case for medium sized companies. Finally, Table 14 shows the results for a multiple regression model between the level of innovation and the innovation factors of small and medium-sized companies.

Table 14
Multiple linear regression model

Company	Dependent variable	Predictor variable	Non-standardized coefficient B	Typified Beta Coefficient	t	Sig.
Small (SE)	SE level of innovation	Skills	0.076	0.086	0.270	0.793
		Measurement	-0.017	-0.029	-0.123	0.905
		Management processes	0.416	0.494	1.586	0.144
		Inforamtion technology	0.183	0.398	1.166	0.271
		Constant	1.775		2.478	0.033
Medium (ME)	ME level of innovation	Skills	-0.851	-0.601	-2.135	0.058
		Measurement	0.606	0.681	3.847	0.003
		Management processes	1.867	1.196	3.011	0.013
		Information technology	-0.674	-0.397	-1.460	0.175
		Constant	0.350		0.503	0.626

Source: Own elaboration based on the results obtained in SPSS 21®

In the results of the multiple regression it can be observed that the innovation factors in small companies are not determinant, since they are not significant for a regression model. Whereas in medium-sized companies, the measurement factors ($p=0.003$) and management processes ($p=0.013$) are significant for the model ($p<0.05$), and thus they are significant in their level of innovation.

Conclusions

Presently, the behavior of companies is becoming more complex due to the constant transformation that society is going through due to the dynamic demanded by globalization. Therefore, according to theory the factors of innovation, management processes, skills, measurement and information technology must be strategic axes, both in small and medium-sized textile companies, in order to achieve better levels of innovation and become more competitive. However, it can be observed that regardless of geographical location, old beliefs still prevail in this sector and strongly influence the behavior of SMEs, resulting in low levels of innovation.

The results of the inferential analysis allowed concluding that in medium-sized companies the measurement and management processes are significant, resulting in a higher level of innovation. Whereas small companies do not consider them significant, which results in a low level of innovation; therefore, the hypothesis presented in the research is accepted and the objective that was established is met. These results coincide with the ones obtained by López, C., Maldonado, G., Pinzón, S., and García, R. (2016), who establish that business management must promote the formal collaboration with public and private organizations in order to use external resources and create the conditions that will allow obtaining the training, resources, and infrastructure required to implement innovation, evaluate it, and reach a higher level of the same.

Medium-sized companies are characterized by an open attitude towards change, recognizing that strengthening the education level of the personnel, training their directors, evaluating the performance of the directive personnel and middle-ranking officials, integrating quality systems, monitoring their competitors, having updated electronical media, making their management processes more flexible and having more appropriate resources can lead to obtaining a great innovation capacity. On the opposite case, the current profile of small companies with respect to innovation is characterized by a low level of innovation, given that the factors analyzed are

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not a part of their system—they do not know them and assume that their implementation is too hard and will distract them from their ordinary activities—, in addition to the prevalence of the paradigm of mistrust for third parties to guide them through the implementation of improvements.

Regarding product innovation, both in small and medium-sized companies, education and organizational learning are not substantial axes to develop new abilities in their personnel that will allow assuming an entrepreneurial and transformation attitude in their tasks. These results are related with what Moyeda and Arteaga (2016) state, that the innovation of intellectual capital is an input. Unfortunately, most companies do not see it that way. However, considering the research, both types of companies must strengthen their organizational learning with the appropriate training, systematically measure the efficiency of their quality systems so that their products comply with the expectations of the client, permanently monitor the competition to improve and differentiate their products, and overall develop a culture that promotes product innovation.

Regarding process innovation, it was identified that when medium-sized companies implement a change, it is mainly done in the processes. This coincides with the results by Vrgovic, Vidicki, Glassman and Walton (2012), who state that the SMEs are implementing more innovation activities, but in the processes. Similarly, it was identified that although medium-sized companies have a better dynamic to improve their processes with respect to small companies, both lack the capacity and resources to implement new processes. Therefore, they require the creation of capabilities to optimize efficiency, continuously measure the activity of the personnel to reinforce their development, develop the necessary skills in a timely manner, monitor the competition to improve and/or change their processes, and implement quality models to their organizational system to promote continuous improvement and change.

Finally, regarding organizational innovation and despite the fact that medium-sized companies have a greater commitment to make changes in their organizational system and adapt new technology with regard to the small companies, they lack skilled personnel, and this is why the changes made have not resulted in an integral improvement effect that will truly impact their efficiency and competitiveness. However, it is concluded that not only the textile SMEs have a weak culture for organizational change, but also the co-responsible actors such as the chambers, government and the educational sector. Furthermore, the research revealed that both types of companies demand a flexible organization model that promotes the development of skills to adopt new techniques and/or methods, that modernizes and diversifies their means of communication, maintains permanent communication between all areas, with the clients, the suppliers and the different groups of interest, and formalizes collaboration relationships with educational institutions, research centers and the government to develop R&D and innovation activities.

Recommendations

The research allowed demonstrating that it is necessary to support—technically and financially—medium-sized companies to increase their level of innovation. Similarly, due to their importance in the economic and social development, it is required that in small companies all of their interest groups (shareholders, businesspeople, workers, government, education sector and society) contribute to their development by working in teams to boost their innovation in all aspects, as a strategy to reactivate their competitiveness and prevent debilitating this sector.

Furthermore, the organizations responsible for organizing fiscal stimulation programs granted to companies that carry out R&D must diversify and improve their media outlets as a strategy to motivate and incorporate textile SMEs, as is proposed by Ollivier & Thompson (2009).

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