

Factors for manufacturing competitiveness of automotive part suppliers from Nuevo Leon, Mexico: a literature review

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Abstract

The automotive industry represents one of the most important industries for the economic growth of Mexico. In the last seven years, Mexico has reached the tenth place among the worldwide producers of light automobiles and became an important automotive part supplier. It contributes with 3.5% of the world production. Nuevo Leon takes part of the cluster of automotive parts suppliers with the higher importance for the country. By using a systematic literature review, obtained from data bases of two universities, University of Monterrey (UDEM) and Autonomous University of Nuevo Leon (UANL), the present research finds six factors with high impact to the manufacturing competitiveness of the automotive parts suppliers, in the automotive industry. These are: quality, product innovation, process technology, qualified capital human, support of the automotive cluster, and information technology. In scientific research a relevant issue is measurement. Factors that form part of the measurement process are discussed. This study presents an analysis of each one of these factors, and how they have an impact to the manufacturing competitiveness of the automotive industry.

Keywords

Automotive industry, manufacturing competitiveness, part suppliers, quality, innovation

1. Introduction

Mexico has gained strength as one of the leading automotive part supplier manufacturers at global level. It has positioned as a producer and exporter of vehicles worldwide. According to data from the International Organization of Automobile Production (OICA), in 2015, Mexico took the seventh place as a producer of automobiles that grew by 5.9% compared to 2014, as well as the thirteenth place in sales globally, of 144 countries (OICA, 2015). Both, its geographical location and its low labor costs have encouraged foreign investment, with the presence of the main original equipment manufacturers (OEMs); this has increased the amount of automotive part suppliers' factories in the country, and for consequence it has increased the sources of direct and indirect employment (CEFP, 2015).

Three levels of competitiveness affect the success of companies in a global competitive environment: the competitiveness of the company, the competitiveness of the industry in which it operates and the competitiveness of the country where the company is located (Ülengin, Önsel, Aktas, Kabak, & Özeyd, 2014).

According to the Global Competitiveness Index 2016 (GCI), published at World Economic Forum (WEF), the concept of competitiveness is defined as the set of institutions, policies and factors which determine the level of productivity of an economy, and transform the level of prosperity a country can achieve. In this index Mexico is in the 51st place, recovering from its last period in which it was in place 57 (WEF, 2016).

The competitiveness of a manufacturing enterprise is defined as the performance of its industrial skills, its cost superiority, and its political-economic environment (Ülengin, Önsel, Aktas, Kabak, & Özeyd, 2014). The results of the latest Global Manufacturing Competitiveness Index 2016 (GMCI) indicates that the manufacturing sector is a driver of the global economy, given its influence on infrastructure development, the generation of direct employment and its contribution to GDP (Deloitte, 2016). Mexico's competitive advantages are mainly the high availability of skilled labor, competitive operating costs, strategic geographic location, attractive domestic market, legal certainty, an extensive supply chain, and an export capacity of more than 45 countries, the number of free trade agreements, and finally the decades of experience in this sector (ProMéxico, 2015).

The competitiveness of the automotive industry is related to the competitiveness of the nation in which it operates, and can be multifactorial (Ülengin et al., 2014). The state of competition of an industry depends on five basic competitive forces: the power of supplier negotiation; Threats from new consumers; Threats from substitute products or services; And the bargaining power of buyers (Porter M. E., 1998). In Mexico, the advantage it has due to the geographical proximity to the United States of America and the North American Free Trade Agreement (NAFTA). This has allowed the growth of foreign investment, and the quantity of products assembled in the manufacturing sector, have led the country to be an important global exporter (Vázquez-López, 2014). Mexico not only has free trade agreements with the United States and Canada, but also with 42 other countries (Deloitte, 2016). This, in addition with the low labor cost and the low cost of energy inputs, has allowed the opening to the international markets.

The success of the automotive industry depends on the performance of its suppliers, which is crucial for its development and competitiveness (Garza-Reyes, Ates, & Kumar, 2015). Factors influencing the competitive advantages of regional industries are the proximity to customers, supplier support, rivalry and competition, and resource conditions. The configuration of these factors will affect the competitiveness of the industry (Ando, 2013).

The present investigation aims to research the manufacturing competitiveness of the automotive industry (MCAI) of the first level parts suppliers Tier 1 of the State of Nuevo Leon, Mexico. Statistics published in the Automotive Cluster of Nuevo Leon (CLAUT), reports that the exports of the State of Nuevo Leon in 2015 amounted to 46,653 million USD, of which the automotive sector accounted for approximately 33%. In the same year, the exports of this industry in Nuevo Leon are estimated at 15, 579 million USD, which compared with the year 2014 had a growth of 3.6%. Additionally, the direct employment of automotive sector accounted for about 75,000 in 2015 with expected growth of 14% for 2016 (CLAUT, 2016).

This article presents the factors that have a positive impact on the MCAI of parts suppliers, through a literature review showing the theoretical support extracted from the scientific community in the world, mainly from the most competitive countries in the automotive industry, located in America, Asia, Europe and Mexico. The method used for the literature review was the extensive search of articles in databases of the Autonomous University of Nuevo Leon and the University of Monterrey, such as Emerald Insight, ESCOHOST, PROQUEST, and PRIMO search engine. Mainly literary reviews and scientific research reports were used. The search was expanded, and it was tried to include articles of high impact factor, adhered to JCR, Scopus, or level Q1, Q2 and Q3 of the classification Scimago Journal & Country Rank.

2. Manufacturing competitiveness of the automotive industry: a context of Mexico in a global view.

The high competition in the automotive industry in Mexico has caused the OEMs to force automotive parts suppliers to perform research and development functions, in order to achieve the latest technology. However, in Mexico there is a lack of linkage with the academic sector, as well as a lack of articulation of public policies of the government to encourage research and development in companies of the automotive industry. This has affected to respond the demands of the OEMs, and therefore has impacted on its competitiveness (Parra-Gaviño, Pastor-Román, & Gómez-Ortíz, 2015). In Mexico, linking universities with companies must go beyond the professional practices of undergraduate students, but also would be work in research and development; make investments in equipment that universities can apply to generate new technological knowledge; and also consulting on process innovation (Mendoza-León & Valenzuela-Valenzuela, 2014).

ProMéxico (2015) is convinced that the best way to develop the country's automotive industry is through liaison with academia, government and private industry, which are components of the clusters. According to the Ministry of Economy (2014), the northeast region of auto parts producers integrated by the states of Coahuila, Chihuahua, Nuevo León and Tamaulipas, are the most important cluster of the automotive industry in Mexico. In this area we find the automotive cluster in Nuevo León, whose industry is composed mainly of auto parts suppliers to OEMs, Tier 1, Tier 2 and Tier 3, respectively (CLAUT, 2016).

International competition and the need to have a competitive and innovative industry has led companies in the same industry, to define new forms of competitive advantages, such as the agglomeration of businesses, universities, research centers and the presence of government, called cluster (Fundeanu & Badele, 2014). Supporting this theory, a cluster should include companies, government agencies, educational institutions, training providers and other providers that meet the needs for information, research and technical support (Porter M. E., 1990).

In order to respond to the needs of the industrial sector, the concept of competitive priorities arises, which are the areas in which future decisions are focused and where manufacturing concerns are concentrated, related to business strategies (Phusavat & Kanchana, 2007). Several authors (Joshi, Nepal, Singh-Rathore, & Sharma, 2013) and (Nauhria, Pandey, & Kulkarni, 2011) are agree with (Phusavat & Kanchana, 2007), which manufacturing's competitive priorities are cost, quality, delivery, flexibility, customer focus and relationship management, and even innovation and technology. Also, the community of operations management researchers have grouped a set of their key performance indicators as the competitive priorities for manufacturing, these are: quality, cost, delivery and flexibility. However, in the current context there are other key indicators that also have a significant effect on competitiveness, such as environmental factors, technology, customer demand, and business relationships (Joshi, Nepal, Singh-Rathore, & Sharma, 2013). All this aims at increasing productivity, improving customer satisfaction, and lowering costs, and thereby increasing their level of competitiveness (Lefcovich, 2009).

Nurcahyo & Wibowo (2015), brings in their research two types of competitive priorities, those related to the manufacturing system and those corresponding to product leadership. As for the manufacturing system, the elements that integrate it cost, quality, delivery, flexibility and sustainability; and in terms of product leadership the elements that are a priority are customer perspective, innovation, and product technology.

As for manufacturing systems, it can be said that companies must realize that increasing the productivity of their operations is one of the best elements to achieve cost advantages and quality compared to their competitors. A challenge that Mexico has to solve is the productivity of the manufacturing sector, despite having a better labor productivity index than other emerging economies such as China and India, there is still a significant gap with economies such as the United States, Germany and Japan (Deloitte, 2016). Human capital is one of the most important sources of competitiveness of the automotive industry in Mexico, due to its high quality and specialization (ProMéxico, 2015).

The search for improved productivity represents a clear importance in business competitiveness (Grossman, 1993). For the performance of Serbia's manufacturing companies, quality management is key, that is, to increase the competitiveness of the automotive industry, one of the main elements of suppliers of auto parts is the manufacture of products of quality (Heras, Marimon, & Casadesús, 2009). The existence of a high quality of processes reduces the variability and the defects of the products. Also, improving quality produces customer satisfaction, increases productivity and offers competitive advantages. All this leads to greater market share and better financial results, which translates into high competitiveness of the company and therefore of its respective industry (Pešić, Milić, & Stanković, 2012).

In their study Pešić et al. (2012) identified that the main factors which has a significant impact to the quality of a business are the improvements proposed by human capital, the employees' labor competencies, the speed of delivery

of the products, and the relationship with the providers. The human capital of an organization plays a very important role in the competitiveness of it.

According to a study carried out in manufacturing companies with more than 500 employees, in Spain, both individual skills, the capacity for innovation and adaptation, and the approach to results are the most relevant to promote the company (Díaz-Fernández, López-Cabrales, & Valle-Cabrera, 2014). According to the United Nations Educational, Scientific and Cultural Organization (UNESCO), in 2011 the percentage of graduates of academic engineering and manufacturing programs was higher in Mexico than Brazil, Germany, Spain, the United States and UK. And the number of direct jobs in Mexico generated by the automotive industry was 690,000, of which 90% went to auto parts companies (ProMéxico, 2015).

Product leadership, innovation and technology are key factor in the industrial sector. Mexico must invest in increasing research and development centers for innovation and product technology, as well as designing components for parts of the automotive industry, in the coming years (ProMéxico, 2015). In addition, it will be important to invest in technology for industrial processes, such as forging, stamping and smelting that supply the same industry, so that it can allows to compete in international markets (ProMéxico, 2015). The combination of private and public funding in research and development is important for the competitiveness of the automotive industry (Kamp, 2008).

The development of software and use of information and communication technologies in Mexico in manufacturing and business processes boosts the country's economy and competitiveness. The fastest growing and developing industries for the country are automotive, electric-electronics, aerospace and medical devices, so it is relevant that these industries invest in the installation of such technologies (ProMéxico, 2015).

A research study on the case of Turkey's automotive industry shows that its competitiveness depends on the following factors: suppliers' quality level, the effect of taxes, ease of access to loans, innovation capacity, and investment by companies in research and development, availability to the latest technology, and collaboration of universities with companies for research and development (Ülengin et al., 2014).

Several authors point out the importance of a set of elements that have a positive impact on the MCAI. We can distinguish elements of the environment, such as government support, collaboration of universities with the business sector for research and development, and productivity of the automotive parts suppliers are integrated into cluster strategies, which have the objective to benefit companies in the sector. Within these companies, factors such as innovation and technology, quality, and labor competencies of human capital interact to improve organizational performance, which affect MCAI. Figure 1 shows these elements interacting with each other to reach the MCAI of suppliers of automotive parts.

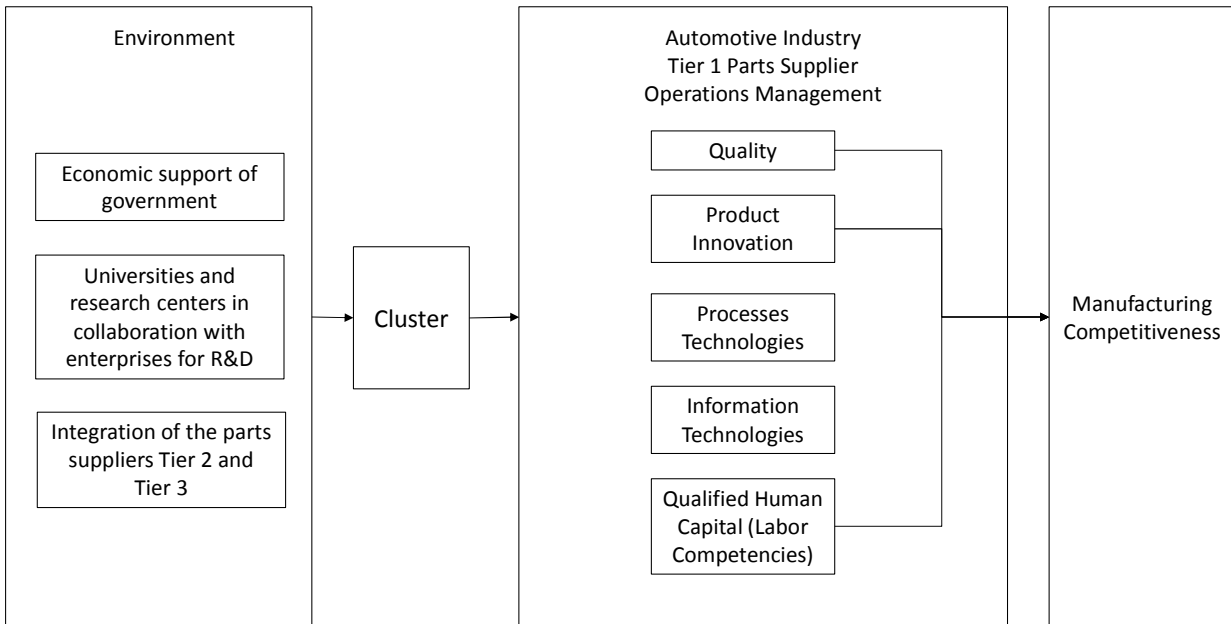


Figure 1. Conceptual framework of the research: manufacturing competitiveness of automotive industry

3. Factors for manufacturing competitiveness of the automotive industry.

An important indicator to measure the regional and national economic development situation, as well as the overall competitiveness of a country, is the competitiveness of manufacturing companies in the automotive industry, which is an integral result of market efficiency, innovation, management and environmental factors (Cao, You, Shi, & Hu, 2016).

The reason why the automotive industry is the engine of the economy is that other industries such as steel, petrochemicals, pneumatics, and others are turning around it, so any change in this industry moves the economy of a country (Cinicioglu, Önsel, & Ülengin, 2012). For example, the automotive supply chain plays a strategic role in the economic base of countries such as the Czech Republic, Poland, Slovakia and Turkey, given their contribution to domestic production and industrial development, employment and technological development (Cinicioglu et al., 2012).

The measurement parameters serve as a benchmark for policy development and other ways to judge the success of a country's competitiveness in a global context, such as the Global Competitiveness Index (GCI) of the World Economic Forum (WEF), which is recognized by many countries for a correct measurement of the strengths of the competitiveness of manufacturing (Cinicioglu et al., 2012).

A study by Kabak et al. (2014), considered the WEF indicators for the competitiveness of nations as the fundamental source of criteria for measuring MCAI. His study defines criteria that impact the competitiveness of the automotive industry in Turkey, whose result is a strong relationship between the capacity for innovation and the availability of the newest technologies with a positive impact on the quality of the local suppliers of the automotive industry, also had the highest impact on improving the size of the domestic automotive market.

Through a study carried out in India, different strategies for the competitiveness adopted by SME automotive parts suppliers were analyzed, and it was concluded that investment, quality, cost and competition strategies are significantly correlated with MCAI; where process automation, market research and employee welfare are the main investments made by these companies, as well as the involvement of customers in determining quality standards, target market identification and improvement of the environment of work are the most important competences (Singh et al., 2007). Cinicioglu et al. (2012) with their study measure the factors that affect the MCAI, which showed that the efficiency of the automotive sector in Turkey depends basically on the levels of quality, availability to the latest technologies and the level of adoption of these new technologies that own automotive parts suppliers.

Some other results shown in research reports by several authors reflect environmental and sustainability factors that have a positive impact on MCAI. (Li, 2014) concludes that the use of business assets; The environment, social responsibility and organizational knowledge, as well as management efficiency and financial gains have a significant impact on the green competitiveness of China's automotive industry; and Triebswetter & Wackerbauer(2008) show, in their case study of the innovation of environmental products of parts suppliers of the automotive industry, important conclusions such as that Germany's environmental policies have generated competitive advantages in companies of this sector.

According to the above, it can be inferred that the MCAI has multiple factors that affect it. Empirical studies presented by authors such as Phusavat and Kanchana (2007); Cinicioglu et al. (2012); Kabak et al. (2014); and Claudine et al., (2016), show strength and consistency in factors such as quality, technological development and innovation with a significant impact on the manufacturing competitiveness. In the same idea, there are other results presented by Singh et al. (2007); and Porter and van der Linde (1995), on the importance of government and market factors for the competitiveness of a nation; finally, various authors such as Triebswetter & Wackerbauer (2008); and Li (2014), participate in environmental and sustainability aspects as drivers of competitiveness in the automotive industry.

It is observed consistency between authors, that quality in manufacture is a competitive priority. This is associated with defect index, reliability, product performance, certifications and standards, and environmental issues (Phusavat & Kanchana, 2007). Several authors, such as (Heras, Marimon, & Casadesús, 2009) and (Pešić, Milić, & Stanković, 2012), emphasize the importance of applying tools and models for the quality of automotive and manufacturing companies in general. Their findings allow us to prove that it is a factor that drives business competitiveness.

In the automotive industry, in studies by authors such as (Jiménez & Moya, 2011), (D'Costa, 2004), (Lassar, Haar, Montalvo, & Hulser, 2010) and (Ülengin, Önsel, Aktas, Kabak, & Özayd, 2014), emphasize that innovation, technology and research and development, are important matter to compete globally. (Bongsebandhu-phubhakdi, Saiki, & Osada, 2009), points out that total quality management and innovation support the competitiveness of the automotive industry, and human resources are required to adopt the necessary competencies to achieve organizational performance.

Different authors point to factors that have an impact on the manufacturing competitiveness. In the automotive industry there is scientific knowledge mainly in countries such as China, Spain, India, Indonesia, Japan, Malaysia, United Kingdom, Serbia, Thailand and Turkey, as well as other authors from Mexico, which present a significant variety of factors influencing competitiveness, as described in Table 1. The factors of quality, product innovation, process technology, qualified human capital, information technologies, and cluster support were selected for the purpose of this study.

Table 1. Comparison of authors and their proposal of factors with positive impact for manufacturing competitiveness

Author	Industry	Country	F1	F2	F3	F4	F5	F6	F7	F8	F9
Phusavat & Kanchan (2007)	Manufacturing	Thailand, China and Taiwan	X								
(Claudine et al., 2016)	Manufacturing	Australia and Sweden	X							X	
(Cinicioglu et al., 2012)	Automotive (parts suppliers)	Turkey	X		X	X					
(Li, 2014)	Automotive	China				X			X		X
(Nurchahyo & Wibowo, 2015)	Automotive (parts suppliers)	Indonesia	X						X		
(Singh et al., 2007)	Automotive (parts suppliers)	India	X						X		
(Triebswetter & Wackerbauer, 2008)	Automotive (parts suppliers)	Germany									X
(Kabak et al., 2014)	Automotive (parts suppliers)	Turkey	X	X	X						
(Gabriel & Pessl, 2016)	Manufacturing	Austria			X		X				
(Vázquez-Avila, Sánchez-Gutiérrez, & González-Urbe, 2015)	Manufacturing (SMEs)	Mexico		X	X	X					
(Ülengin, Önsel, Aktas, Kabak, & Özyayd, 2014)	Automotive	Turkey	X	X	X			X	X		
(Joshi, Nepal, Singh-Rathore, & Sharma, 2013)	Automotive (parts suppliers, Tier1)	India	X		X				X	X	
(Bevis, 2011)	Automotive (parts suppliers)	United Kingdom				X					
(Lassar, Haar, Montalvo, & Hulser, 2010)	Electronics and TI enterprises	Mexico	X				X	X			
(Jiménez & Moya, 2011)	Automotive (parts suppliers)	Mexico (Nuevo Leon)	X	X				X			
(D'Costa, 2004)	Automotive	India	X	X	X	X		X		X	

Note: Factors with positive impact for competitiveness, F1: Quality; F2: Innovation; F3: Processes Technologies; F4: Human Capital; F5: Information Technologies; F6: Collaboration of government, universities and enterprises (Cluster support); F7: Costs and financial elements. F8: Flexibility; F9: Environmental factors and sustainability.

4. Literature review for the factors of the MCAI.

4.1. Quality.

According to the literature review of this study, different currents and theories are found where quality has an impact on competitiveness. Pešić et al. (2012), proves that the tools of total quality management favor the competitiveness of the companies of various industries of the Republic of Serbia. (Heras, Marimon, & Casadesús, 2009), support this idea by proving that self-assessment based on the European Total Quality Management Model (EFQM), significantly impacts the competitiveness of companies in the productive sector and in community services of the Basque country, of the European Union. Both authors point out that tools and methods such as six sigma and statistical quality control are the most important to improve the quality of companies.

Other authors oriented to the automotive industry, such as Curcovik, Vickery, & Droge (2000), whose study in automotive industry firms in Mexico, Canada and the United States proves that the quality of Tier 1 suppliers of the automotive industry, has two dimensions, product quality and service quality; and authors such as Ülengin et al. (2014); And Joshi et al., (2013) agree that quality is a key element, among others, that strengthens competitiveness. (Melgoza-Ramos & Álvarez-Medina, 2012); (Garza-Reyes, Ates, & Kumar, 2015); and (Pepper & Spedding, 2010), they conclude that their processes in the automotive industry are being improved by using precise techniques and methods, such as lean manufacturing, and allows for operational efficiency, reaching the MCAI. Garza-Reyes, Ates,

& Kumar (2015), concludes in his study that the use of lean manufacturing and quality tools in companies that supply auto parts has a significant impact on the competitiveness of the automotive industry.

4.2. Product Innovation.

The new paradigm for achieving international competitiveness is based on innovation, which is obtained by organizations that have the capacity to continuously improve and innovate, both processes and products or services (Porter & van der Linde, 1995).

The product innovation goes from the constant improvement of the product, to the development of new products; and it is essential for manufacturing companies in India's automotive industry to carry it through research and development (Nauhria, Pandey, & Kulkarni, 2011). The cars of the future will be characterized by significant developments in product technology; this is the development of fuel-efficient vehicles, hybrid vehicles and improvements in engine and exhaust systems, reduced emissions, sound and vibration, improved telematics are the important areas that should make efforts in research and development (Nauhria, Pandey, & Kulkarni, 2011).

Improved environmental performance in terms of product innovation in the automotive industry is one of the characteristics that will allow differentiation between competitors, and will be able to direct the transformation of technologies, such as design of lighter structures and alternative sources of energy (Triebswetter & Wackerbauer, 2008). Environmental legislation and regulations drive environmental innovation, and beyond just controlling pollution, they must cause business productivity; it is that success consists of innovative solutions that include environmental sustainability and industrial competitiveness (Porter & van der Linde, 1995).

Environmental legislation is an important factor in boosting and triggering innovation in environmental products and in improving the competitiveness of the automotive industry, but must be aligned with the strategy and customer requirements (Triebswetter & Wackerbauer, 2008).

In a study of the competitive priorities of India's automotive industry, it is concluded that the priorities that favor product leadership are customer perspective, product innovation and product technology. These should be considered in the next decade to increase the global competitiveness of the automotive sector (Nauhria, Pandey, & Kulkarni, 2011). At the same time, an investigation into Japan's automotive industry shows that in the early 1990s automotive companies made alliances with foreign auto parts suppliers and injected investment into research and development of new process and product technologies, that led them to increase their competitiveness in international markets (Kwintiana & Chihiro-Watanabe, 2005).

Kamp (2008) in his research corroborates that public policies that encourage research and development in the automotive industry manage to improve the competitiveness of a region. As a result of its study of 200 European companies, it showed that they agree that the combination of private and public funding in research and development is important for the increase of the MCAI of European countries. The product of research and development are patents. In its research report (Agostini & Caviggioli, 2015) it contributes the differences in the activities of generation of patents, and the selection of automobile manufacturers and their auto parts suppliers; And concludes that the issue related to the value of the patent represents an emerging area of interest in the field of innovation partnerships for OEMs and auto parts suppliers from Italy.

4.3. Process technologies.

Technology is important for competitiveness as long as it has a significant impact on the firm's competitive advantage or the structure of the industry and the way to do so is through the supply chain, since a set of activities is required a set of technologies (Porter, 1985).

A competitive advantage of the automotive industry is related to new product technologies and improvements to existing technologies (Nauhria, Pandey, & Kulkarni, 2011). This is the case of new technologies in the automotive industry related to environmental sustainability (Lin, Chen, & Huang, 2014).

Strategies for process technology are those related to cost reduction, such as reducing the learning curve of the workforce; the development of new processes to generate economies of scale; Achieve better delivery time; maintaining better quality indices; among others (Porter, 1985).

Technologies, whether products or processes, provide the main way to differentiate products, reduce costs and provide new business opportunities; thus, technology management is a crucial element in a company's success (Baines, 2004).

Bongsebandhu-phubhakdi et al. (2009) in his study, he says that it is necessary for companies that supply automotive parts to use high quality management techniques and adopt several technologies such as CAM, CAD and CNC, as well as the administration of the technology in order to reduce the internal rate of defects, and in turn, should improve their level of technology according to the demands of the same assemblers, and thus be competitive in the market.

4.4. Qualified Human Capital.

According to (Díaz-Fernández, López-Cabrales, & Valle-Cabrera, 2014), what makes an organization's human capital valuable are its individual competencies, which must be aligned to the requirements of the strategy defined to be competitive. The automotive industry has adopted different models for human capital management. From the approach of Ford, at the beginning of century XX, where the tasks of work were manual and of repetitive form in the lines of assembly; To the current of Japan in the 1980s, where employee involvement is encouraged and its intellectual contribution is important, with a greater focus on achieving productivity and competitiveness (Zacharatos, Hershcovis, Turner, & Barling, 2007).

The management of human capital by labor competencies is an instrument aimed at providing greater productivity and utility for companies (Martínez B. , 2013). It is the company managers, who must strategically decide what competencies their employees must have, and in which they must invest in their training; In the case of the automotive industry those who guide productivity and innovation processes are the knowledge and skills in the principles of lean manufacturing (Bevis, 2011).

A supportive environment for growth, market fundraising, and a shortage of technical labor are important limiting factors for the competitiveness of auto parts suppliers in the automotive industry; While cost, quality and delivery time are the main drivers of it. Automotive companies must invest in the development of their employees' job skills, as there is a significant impact on their competitiveness (Singh, Garg, & Deshmukh, 2004). Intellectual capital, such as knowledge and technical skills, play an important role in creating competitive advantages and improving business value, is even considered the most valued asset and the most powerful element to compete in the market (Leal-Millan, Roldan, Leal-Rodriguez, & Ortega-Gutierrez, 2016)

A study developed in 84 automotive Tier 1 parts suppliers from Spain, which use a hierarchical regression analysis, found a positive and significant relation between the lean manufacturing practices and the organizational performance, ($\beta=0.353$; $p<0.001$), with a moderating variable the workforce development, which also presents a positive and significant relation with the lean manufacturing practices, ($\beta=0.377$; $p<0.001$), as well a positive and significant relation with organizational performance, ($\beta=0.168$; $p<0.001$) (Uhrin, Bruque-Cámara, & Moyano-Fuentes, 2017).

The case study made in the General Motors from Silao, in Guanajuato, Mexico, presented findings as the organizational structure of the teamwork, the training, the learning and the incentives linked to economic rewards and growth in the company, have a positive impact to the workforce performance. Also they develop the labor competencies, increase the production and favor the flexible organization; all of this improves de labor productivity (Martínez, García, & Santos, 2014).

4.5. Information technologies.

Information technologies (ITs) have become a catalyst for organizational processes, and undoubtedly constitute tools to support business management, leveraging the construction of strategies aimed at competitiveness and Innovation, thus generating sustainability for the organization and society (Gálvez-Albarracín, Erazo, & Palacios, 2014).

ITs are relevant for the competitiveness, because it support the management of the operative and administrative processes of an organization. For example, it facilitates sales processes with the use of internet; reduce costs of global communication with customers; supports management systems with the use of enterprise resource planning software (ERP); supports operative processes with the use of materials requirement planning software (MRP), and others (Hirsh, Almaraz-Rodríguez, & Ríos-Manriquez, 2015).

ITs in the web ambiance have a significant influence on the different key performance factors of companies as the global performance, the human relations, the internal processes and the relations with the environment (Gálvez-Albarracín, Erazo, & Palacios, 2014). The use of ITs allows the companies to improve the work systems and increase its competitiveness (Cuevas-Vargas, Estrada, & Larios-Gómez, 2016).

The incorporation of ITs facilitates the innovation of processes, and in consequence increases productivity, reduce costs, improve the quality of products, and therefore, their competitive position (Alderete, Jones, & Morero, 2014). Cuevas-Vargas et al. (2016) reaffirm this position, with the SMEs study of industrial sector at Guanajuato, which describe ITs as a key facilitator for product, process and administrative systems innovation.

A study made to 140 automotive parts suppliers at Seville, Spain, using a regression analysis, proves that ITs have a positive and significant effect to the knowledge creation between enterprises, called relational learning, ($\beta= 0.689$, $p<0.001$), also it has a positive and significant effect to the green innovation performance, ($\beta= 0.512$, $p<0.001$). Both improve the business performance and therefore the competitiveness (Leal-Millán, Leal-Rodríguez, Roldán, & Ortega-Gutiérrez, 2015). Other study made to 89 automotive parts suppliers and 74 steel companies, made the

finding that the companies have adopted different TIs in the next participation: internet (98%), web sites (36%), intranet (63%), ERP (28%), SCM y CRM (35%)—Supply Chain Management, y Customer Relationship Management, respectively—. All of them lead to the improvement of the organizational performance (Alderete, Jones, & Morero, 2014).

4.6. Support of the automotive cluster.

The definition of cluster according Porter (1990), is a group of interconnected companies and associated institutions in the same field or sector, with a close geographic location, and united by common and complementary themes. The clusters focus their attention to the geographical proximity, concentration and networking (Yildiz & Aykanat, 2015). The collaboration between the enterprises through the cluster is the key for the economic development of the automotive industry (Jiménez & Moya, 2011). The cluster allows the involvement of universities, enterprises, research centers and government, working together in a same objective, and therefore creates competitive advantages of a region or a sector (Yildiz & Aykanat, 2015).

A research study in the automotive industry of Thailand identifies that the geographical proximity was a facilitator for the communication between companies, and also allows the implementation of just in time system to achieve delivery to the OEMs with timely response; this stimulate the regional collaboration, and is crucial for the improvement of the competitiveness (Kohpaiboon & Jongwanich, 2013).

A qualitative study of three automobile companies in the Czech Republic and Slovakia, Volkswagen, Peugeot and KIA Motors, analyzed the impact of the automotive cluster on competitiveness, and it was possible to identify that the elements that affect the competitiveness of the automotive industry are sharing resources, referring to suppliers, and knowledge, referring to human capital; in addition, the relationship with the government is important to support labor and other situations, and is highly beneficial to compete (Zámborsky, 2012). In the same field, Jimenez & Moya (2011) elaborated a research study of SMEs parts suppliers of the automotive industry of Nuevo Leon, Mexico, and concludes that is relevant the collaboration between companies for the economic development of the region, because allows the linkage with the academy, the economic support of the governments and the integration of the supply chain, and favor to increase the efficiency of the services and improve the quality performance of the parts suppliers.

The determinants for manufacturing competitiveness of each factor are describe in the table 2, as a summary of the findings presented in reviews and research studies developed at the manufacturing sector or the automotive industry. Through these it demonstrates a direct and positive relation with the MCAI. In addition there are show the mainly authors and the countries where the study was made.

Table 2. List of determinants for manufacturing competitiveness: an analysis per factor.

Factor	Determinants for manufacturing competitiveness	Author	Method	Industry	Country
Quality	Statistical process control, Six Sigma, FMEA	(Heras, Marimon, & Casadesús, 2009)	Structural equations modeling	Manufacturing and services	European Union
	Level of application of quality tools and principles	(Pešić, Milić, & Stanković, 2012)	Inferential statistics. Factorial analysis	Manufacturing	Republic of Serbia
	Durability, product reliability, sales service, customer responsiveness, and specification fulfillment	(Curcovic, Vickery, & Droge, 2000)	Inferential Statistics. Factorial analysis and regression analysis	Automotive (Parts suppliers)	North America: Mexico, Canada and USA
	Lean Manufacturing Tools	(Garza-Reyes, Ates, & Kumar, 2015)	Inferential and descriptive statistics.	Automotive (Parts suppliers)	Turkey
	Methods for quality processes and operational efficiency using Lean Manufacturing tools	(Melgoza-Ramos & Álvarez-Medina, 2012)	Case study	Automotive (Parts suppliers)	Mexico
	Lean Manufacturing Tools	(Ghosh, 2013)	Inferential and descriptive statistics.	Manufacturing	India

Factor	Determinants for manufacturing competitiveness	Author	Method	Industry	Country
Product innovation	Product innovation through R&D; development of new product technologies, costs and quality as a competitive priorities.	(Nauhria, Pandey, & Kulkarni, 2011)	Alpha of Cronbach as proof of reliability	Automotive	India
	Environmental government policies. Product environmental innovations	(Triebswetter & Wackerbauer, 2008)	Case study	Automotive	Germany
	Green innovation has a significant impact on the performance of the company.	(Lin, Chen, & Huang, 2014)	Structural equations modeling covariance.	Automotive	Taiwan
	Investment in research and development	(Kwintiana & Chihiro-Watanabe, 2005)	Dimensional analysis	Automotive	Japan
	Public policies encourage research and development	(Kamp, 2008)	Best practices analysis	Automotive	Europe countries
	Patent development	(Agostini & Caviggioli, 2015)	Regression Analysis	Automotive	Italy
Process Technologies	Quality and improvement and innovation of processes	(Ortiz, 2006)	Case study	Manufacturing	Latin-American
	Training of employees in technological tools and tools of quality management and technology management.	(Bongsebandhuphubhakti, Saiki, & Osada, 2009)	Case study	Automotive (Parts suppliers) Tier 1, 2 y 3,	Thailand
Qualified Human Capital	Competences of proactive behavior, orientation to the client and orientation to results.	(Díaz-Fernández et al., 2014)	Structural equations modeling	Manufacturing	Spain
	Competences in tools for the quality management technical capacities for the management of the technology.	(Bongsebandhuphubhakti, Saiki, & Osada, 2009)	Case study	Automotive (Parts suppliers) Tier 1, 2 y 3,	Thailand
	Skills in Lean Manufacturing tools.	(Bevis, 2011)	Case study	Automotive (Parts suppliers) Tier 2 y 3	United Kingdom.
	Training in Lean Manufacturing tools Problem solving skills	(Uhrin et al., 2017).	Regression Analysis	Automotive (Parts suppliers) Tier 1	Spain
Information Technologies	ITs with a significant impact on innovation and negotiation performance	(Cuevas-Vargas, Estrada, & Larios-Gómez, 2016)	Structural equations modeling	Manufacturing	Mexico
	ITs with significant impact on green innovation and business performance	(Leal-Millán, Leal-Rodríguez, Roldán, & Ortega-Gutiérrez, 2015)	Regression Analysis	Automotive (Parts suppliers)	Spain
	Web environment of business information systems.	(Alderete, Jones, & Morero, 2014)	Factorial analysis and regression analysis	Automotive and Steel industry	Argentina
Support of the Cluster	Innovation and technology transfer	(Fundeanu & Badele, 2014)	Case study	Automotive	Romania
	Innovation, technology, collaboration with SME suppliers	(Fuentes & Martínez-Pellégrini, 2003).	Case study	Automotive	Mexico
	Product quality of parts suppliers	(Jiménez & Moya, 2011)	Case study	Automotive (Parts suppliers) Tier 2 y 3	Mexico
	Geographical proximity of the suppliers	(Kohpaiboon & Jongwanich, 2013).	Case study	Automotive	Thailand
	Suppliers integration, innovation and maturity	(Unger & Chico, 2004).	Case study	Automotive	Mexico

5. Conclusions

Through the literature review carried out for the present research, it is possible to identify that there is an important relationship between the factors of quality, product innovation, process technology, qualified human capital, information technologies, and support of the cluster with a positive impact on MCAI. Very consistently, the factors of quality and innovation appeared relevant to increase the competitiveness of manufacturing, and show specific empirical studies in the automotive industry, in auto parts suppliers. We can also observe that in order to make innovation present, research and development is required, and it can be allowed to link the triple helix company, universities and government, to make it a reality, through the automotive cluster of the state of Nuevo Leon.

The factors of qualified human capital and support of the cluster are sustained in the theories of various authors, but with brief empirical studies. For qualified human capital an important gap is discovered since the authors indicate a direct relation with the organizational performance, impacts on the KPI, but very few with a direct relation to the increase of the MCAI.

The factors with smaller studies directly performed in the automotive industry are those of information technologies and process technologies. There are several authors who demonstrate a direct and positive relation of both factors with de MCAI, but in other industries of the manufacturing sector, and very briefly in the automotive industry.

Other finding of the present review is it was found that there are brief studies focused particularly on Tier 1 parts suppliers of the automotive industry, which is the focus of this research study. Those findings form the basis for identifying the knowledge gap that the present study aims to demonstrate in the future with an empirical study.

It can be said that there is sufficient theoretical and empirical support to continue the present study, and to establish the hypotheses that the factors of quality, product innovation, process technologies, qualified human capital, information technologies and support of the cluster have a positive relation on the variable of the manufacturing competitiveness of the automotive industry.

The future research will be to delve more deeply into the issues that are primarily concurrent among the various authors, but also considering the background of the context of Mexico, to strengthen the literature review, and to support existing gaps. In scientific research a relevant issue is measurement. Elements that form part of the measurement process will be discussed. These elements will be the following: the operationalization of the variables, the relationship among theory and measurement, scales as measurements instruments, the meaning of the latent variables, validity and reliability as essential properties of measurement, also including content validity. Through the understanding of these elements, the relevance of the measurement process will be established in order to finally apply the instrument to the of parts suppliers of the automotive industry of the State of Nuevo Leon, and generate results. The final product of this research will be a model of factors that have a positive impact on MCAI.

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