Competencies to adopt Industry 4.0 for operations management personnel at automotive parts suppliers in Nuevo Leon

Milagros Díaz Bermúdez
Academic Coordinator of
Engineering Management Program
University of Monterrey
Nuevo Leon, Mexico
milagros.diaz@udem.edu

Benito Flores Juárez
Dean of the School of Engineering
University of Monterrey
Nuevo Leon, Mexico
benito.flores@udem.edu

Abstract

This study identifies the required competencies of operational management personnel at automotive part suppliers in Nuevo Leon to generate a transition for Industry 4.0. There are several current examples in the literature review discussing the adoption of Industry 4.0; this research compares thoughts and ideas of the different authors that focus on the most optimal management performance to achieve adoption of Industry 4.0. This article presents a method for identifying the current practices in manufacturing sector and also automotive industry that generate technological innovation in the management capabilities. The method incorporates concepts new abilities, lean manufacturing principles, technological innovation capabilities and strategic modeling for organizational learning, enabling analysis regarding dimensions of Industry 4.0 at different contextualization levels, and allowing the proposition of the best competencies for operational managers of automotive part suppliers required to adopt Industry 4.0. The article presents qualitative study, evidence from a survey applied to 15 managers from 10 operational managements that are part of the Nuevo Leon automotive cluster, the participants contribute to confirm that competencies identified to adopt a new scheme of work favors the organizational innovation to adopt an Industry 4.0.

Keywords
Competencies, Operational management, technological innovation, Industry 4.0

Introduction

In history there are events that have brought about radical changes that mainly affect the daily activities of people both in their personal and work life. For companies, these changes are usually big challenges in the levels of their organizational structure since it is not clear what actions to take, what tools or processes to change to be considered competent within the industry to which they belong.

The scientific-technical progress we are going through today has given rise to new ways of living. One of the fields that has had great development has been the industry since the adaptation of the human capital in executing new processes, is product of the innovation and technology that is incorporated to the diverse companies.

This research will allow us to understand significant aspects of the new forms of human capital work that they face in this 4th industrial revolution in order to first know what is currently being done in Tier 1 companies of automotive sector in the state of Nuevo León, to later know what it takes to be able to achieve adaptability to the 4th Industrial Revolution.

1. Problem Statement

Organizations in all areas need to be constantly adapting to the changing conditions of their environment or industry, it is vital for any organization to gain new competitive advantages and defend its current position in relation to its competitors, according to Valadez and Jurado (2016) it is necessary to incorporate the development and technological innovation in the productive processes to increase productivity, with this the organization manages to innovate and in turn generate new technologies with the purpose of obtaining advantages over the others. Firms supporting themselves through organizational learning achieve the application of new knowledge and techniques. Supporting this, Porter affirms that companies and industries are able to be more productive, acquire greater competitiveness than others, and also with more advantages by incorporating the innovations that arise, this also supports the company to have new market opportunities, and this innovation can expand horizons in sectors that other industries ignore (Porter, 1998).

The individual within the organization will be crucial to the process of innovation that was sought to be achieved, through its interaction with the environment. Pavitt (1984) states that companies will be able to adapt in an innovative way using technology as one of their factors, this will allow them to incrementally manage to dominate a large number of variables, involving technological and advanced capabilities.

With all the advances that have been made over time in the so-called knowledge age, the participation of organizations requires them to create and maintain environments that foster learning. A requirement that supports this is through the active and continuous involvement of individuals working in the organization, having optimal physical spaces, friendly systems and media, and the most crucial part to achieve this is to have the disposition of managers To manage leadership styles and teamwork that lead to the adoption of new knowledge and skills on a constant basis of the members with information coming from inside and outside the organization (Gómez, 2016).

In order to face this new era it is necessary to know how to combat technological and innovation changes so that they gradually become integrated in our societies, Fonseca (2017) mentions in the World Economic Forum that there is still a large number of companies in order to prevent these changes, they continue to work the same That as a decade ago, therefore fighting them can save some jobs but this will cause more damage in the future, so it should be clear that what worked in the past will no longer work in the same way in the present .

Given the above, the research problem addressed by this study is considered important, at the state level, because the government is currently promoting Nuevo Leon towards the knowledge and practice of Industry 4.0, and it remains a great challenge to fulfill in the manufacturing sector; at the automotive industry level, it is considered a relevant issue for the cluster in the fulfillment of its goals during 2017, in aspects of learning oriented to employees in innovation, it aims to be more involved in conferences, exchange of practices between members and contribution with educational and public institutions for the production of research that provide valuable knowledge to adopt Industry 4.0. This is why the participation of Tier 1 companies of the automotive cluster in the qualitative study, will achieve for the present study to know the areas with greater opportunity to develop in the managers who support the operation of the companies. This year's conferences, attended by manufacturing employees, coincide with the results of the 2016 Global Innovation Barometer (General Electric Company, 2016), where business leaders and the general public say it will be a great challenge to implement, in companies, the adaptation of new technological and innovative changes. Likewise, it is observed that most companies and individuals strive to adapt to new technological changes and acquire the necessary skills to cope with changes, this ability to adapt should be implemented in the short term in industries, personal metric (Fonseca, 2017).

1.1 General objective

Identify the labor competencies required by a manager of operating areas in auto parts companies of the Automotive Industry to adopt the 4th Industrial Revolution.

1.2 Specific objectives

- Describe the competencies required by the personnel in the area of operational management of companies that supply auto parts in Nuevo León, as proposed by the literature review, which facilitate their adaptability by responding to Industry 4.0.
- Design a measurement instrument to compare the gap between the competencies of operational managers of Tier 1 from the automotive cluster of Nuevo León against the competencies suggested by the literature to adopt the 4th Industrial Revolution.

2. Theoretical Framework

2.1 Competencies

Competence is defined by Boaz (1998) as the critical or key behaviors: knowledge, attitudes, abilities, values, behaviors, and personal attributes that relate more directly to a successful performance of people in their work, functions or responsibilities. Likewise Preciado (2006) agrees that for a certain occupation a set of behaviors, abilities, skills are required, also adding the faculty of analysis, decision making, and transmission of information considered necessary to carry out its position. Gutiérrez (2010) adds that this set of knowledge, skills and attitudes are applied in situations of the productive field and results in effective results that contribute to the achievement of the organization objectives. Competences such as a person's abilities or disposition to solve real problems and to produce new knowledge through their own abilities are based on the intersection of three contributing elements: the individual, the specialty, and the context (Garder, 1993).

In the report Future Work Skills (2011) mentions the new trends that are transforming society, which shows 10 competencies that workers should consider in a future worker, which are: give meaning, social intelligence, adaptive thinking, intercultural competences, computational thinking, new media literacy, transdisciplinarity, design mentality, cognitive load management and virtual collaboration. These competencies mentioned will be important to consider developing in employees to achieve that they perform satisfactorily in an environment that is constantly changing.

According to Dasgupta (2012), an organization that generates and favors learning environments has as main characteristic its adaptation to the changing environment, establishment of three types of levels of learning (individual, group and organizational), exploration of acquired experience, Constant learning, skill development and improvement processes, continuous creation of knowledge, exchange of information and knowledge, and rapid learning. For companies that are generating this type of environment will be able to have a perfect scheme and count the best organizational structures and processes, but constant practice will be the key. Organizational learning can be defined as the various forms or channels that the company uses to build, complement and organize knowledge and routines around their activities and within their cultures, with these channels an adoption is generated by developing organizational efficiency , And also supporting the improvement of the use of the broad skills of members working in it (Chromjaková, 2016). A contribution of Gómez (2016) in relation to innovation is that it is largely linked to organizational learning. Cuevas-Vargas, Estrada and Larios-Gómez (2016) affirm that "Innovation is a critical determinant of the company's performance, so it is essential that companies rethink their strategies to give greater importance to innovation strategies, which Enables them to achieve superior competitive advantages and performance" (p.49). Thus, companies will be able to obtain a profit by investing in their management innovation capacity together with their capacity to innovate products and processes. Therefore, the most important practical implication is that managers must be aware of the strategic potential of organizational innovation in conjunction with innovation capabilities (Camisón & Villas-López, 2014).

2.2 Manufacturers management competencies

Companies in the manufacturing sector will face major challenges because there will be greater use of robots and software, this entails the demand for new skills in the workers, they are required to be highly qualified in information technologies, analytics and research and development for To be able to complete tasks related to: data-based quality control, robot-assisted production, automotive logistics vehicles, intelligent supply network,

production line simulation, predictive maintenance, machines as a service, self-organized production, additive manufacturing of complex parts (Lorentz, Rüsmann, Strack, Lueth & Bolle, 2015).

It is because of the aforementioned that managers must have the following competencies for their performance: goal oriented, encourage teamwork, commitment and involvement with employees. Likewise for the practices related to the development of the workforce the person of management level according to Uhrin, Bruque-Cámara & Moyano-Fuentes (2017) must comply with the following: (1) development of active skills; (2) highly skilled employees; (3) multifunctional workforce; (4) exchange of opinions and ideas (feedback); (5) problem solving skills; And (6) self-directed work teams. Therefore, it is important that senior managers or management areas have managerial skills because, according to Kor and Mesko (2013), they contribute to establish a dominant logic in the company that is defined in routines, procedures and capabilities that influence the implementation of strategies and allow the adoption of new options for growth and innovation, and these capabilities allow the manager to build, integrate and reconfigure the resources and competencies required by the organization. On the other hand, a study by Ruiz-Jimenez (2015) proposes the influence of the management capacities in the innovation of products and processes, as the two main areas to evaluate the performance of the innovative process. To achieve process innovation, the management team is required to be able to manage resources efficiently and capture the synergies between resources located in different parts of the organization (Tidd, 2000).

During this innovation process the human skills of senior managers are of great relevance in achieving the performance of innovation. Employees are required to be highly committed as relationships based on trust contribute to an organizational climate conducive to collaboration and support. Lorentz et al. (2015) points out that "soft" skills will be more important because employees will have to be more open to change, have greater flexibility to adapt to new roles and work environments and become accustomed to continuous interdisciplinary learning, To put into practice their human capacities so that communication and trust increase, and to achieve as a result a climate of work where knowledge sharing is encouraged.

2.3 Industry 4.0 competencies

Gabriel and Pessl (2016) point out that "The main objective of Industry 4.0 is to strengthen and extend the long-term competitiveness of the company by increasing the flexibility and efficiency of production through communication, information and intelligence" (p. 133). This new revolution involves three areas that are very important, such as automation, robotics or the digitization of everything, but the aspect that plays a key role is the internet of things or rather internet of everything (Basl, 2106). It involves the interconnection of several elements in order that organizations are creating intelligent networks along the entire value chain that can be controlled autonomously. These networks help reduce process time, product development time, generate real-time transparency and enable faster, more flexible decisions.

The authors Li, Wang, Tao, Jiang, and Chai (2010) point to the term Cloud Manufacturing as a new network manufacturing paradigm that organizes cloud manufacturing resources according to the needs and requirements of consumers for provide a variety of manufacturing services over networks (e.g. the Internet). The core of cloud manufacturing lies in the establishment of the cloud manufacturing platform, which is based on many technologies (Liu, Y., Xu, X. 2017, pp. 034701-2).

Experts agree that the manual execution processes that are done properly by people skills such as intelligence, creativity, empathy or flexibility will remain vital. The results obtained in an empirical study of production in the future coincide with 60.2% of the respondents stated that human work will continue to play a very important role in future production; 36.6% considered human work as a vital role within the organization (Gabriel & Pessl, 2016).

Increased use of care systems means that the qualitative change brought about by Industry 4.0 is likely to be positive for the workforce. Works that are routine will decrease while jobs that require flexible response, problem solving, and personalization will increase (Lorentz et al., 2015).

Currently the government of the state of Nuevo Leon is promoting practices and knowledge of Industry 4.0 in the manufacturing sector in order to position the state as the expert of the Mexican Republic. On the part of the Automotive Industry, during the months of March to June, there have been events related to Industry 4.0 so that employees know what this new change is about. On the other hand, companies that are dedicated to automation have

been involved to support the automotive industry, such as the implementation of different types of collaborative robots; these companies give the necessary training to employees.

2.4 Operational management competencies

Bevis (2011) points out that 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. Tamás & Illés (2016) agree with Bevis but in addition to their contribution, they point out that new possibilities for improving efficiency have become available using the devices of Industry 4.0 in conjunction with the lean philosophy. It is important for the above mentioned the training of problem solving capacity of workers through: (1) development of new intelligent logistics solutions; (2) improvement of the value stream mapping method; and (3) application of simulation models.

Senior managers can also improve the development of successful innovative processes by using their technical skills to design procedures that lead the organization to improve its performance. Implementing innovation in organizational processes requires a high level of technical skills that encourages and enhances individuals' ability to generate new and improved procedures (Jack, Anderson & Connolly, 2014).

The technological innovation capabilities are considered by Bin Zainuddin (2017) relevant because they operate in companies as a strategic resource as it allows them to achieve a sustainable competitive advantage when they are in a dynamic environment. Also, these technological innovation capabilities are considered to be of great impact as they are a strategic resource that enables companies to build performance in a dynamic environment, especially in high technology industries such as the automotive industry, which faces a rapidly changing environment. The framework of technological innovation capacities is made up of seven dimensions, three of which are of importance for the study: (1) learning capacity is the ability to find, integrate and develop new knowledge important for the competitive success of a company; (2) research and development capacity indicates the experience of a company to assimilate the research and development strategy, the execution of projects, research and development expenditure and the management of the product portfolio; (3) the capacity to allocate resources is the ability of the company to organize and develop its technological, financial and human resources in the innovation process.

Table 1 below shows the competencies found in the literature and considered relevant for the adoption of Industry 4.0 in the automotive industry. They competencies are categorized into five dimensions, the subject in relation to whom the authors mentioned and constantly mentioned the authors in their findings

Table 1. Synthesis of competencies found in the literature

Author	Dimension	Competencies
Dasgupta (2012); Chromjaková (2016)	Organizational Learning	Encourage constant learning, develop skills and improvement processes, create constant knowledge in your team, exchange information and knowledge, have a rapid learning process, empower workers, encourage participation in decision-making, develop skills in employees.
Gómez (2016); Cuevas-Vargas, Estrada y Larios-Gómez (2016); Chromjaková (2016); Camisón, C., & Villar-López, A. (2014); Uhrin, Á., Bruque-Cámara, S., & Moyano-Fuentes, J. (2017)	Innovation Management	Ability to generate new management practices, creativity in designing strategies to introduce new practices, collaboration with external relations (suppliers, public institutions and researchers).
Davies, A., Fidler, D., & Gorbis, M. (2011)	Environment	Social intelligence, adaptive thinking, intercultural competences, computational thinking, literacy in new media, transdisciplinarity, design mentality, cognitive load management and virtual collaboration.
Cuevas-Vargas, Estrada y Larios-Gómez (2016); Liu, Y., Xu, X. (2017); Li, Wang, Tao, Jiang y Chai (2010)	Information and Communication Technologies	Cloud Manufacturing software management for administrative activities, e-Leadership skills.
Lorentz, M., Rüsmann, M., Strack, R., Lueth, K. L., & Bolle, M. (2015); Tamás P., & Illés, B. (2016).	Automotive Industry	Open to change, have great flexibility, continuous interdisciplinary learning, knowledge of simulation models, knowledge of lean philosophy, problem solving, able to adopt new models of work and organization.

3. Methodology

3.1 Type of study

This research is an exploratory study that through a survey obtains indexes that allow contrasting the postulates of the experts in these subjects investigated in the literature review with the results of the field research.

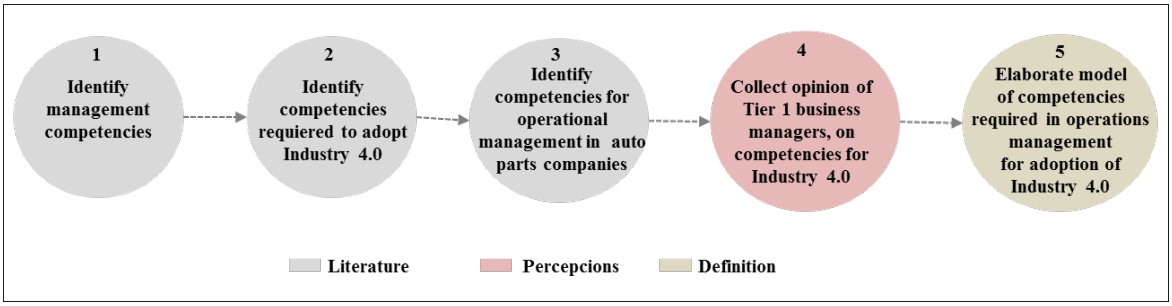
3.2 Participants

The construction of the model was based on a review of the literature, as well as the qualitative study carried out in 10 automotive parts suppliers in Nuevo León, involving 15 managers in the operating area.

3.3 Techniques of data collection and model construction

The research methodology for the collection of information from the study is made up of five phases, ranging from the general to the particular; in figure 1 the phases can be observed.

Figure 1. Steps for Research Methodology



In the first phase, the literature review of the texts and the research will allow obtaining information relevant to the study, on the term "competences" in the labor and management level, with the aim of having a greater understanding of the main purpose to be investigated in the present study.

In the second phase, the deep investigation of the term "Industry 4.0", the changes that it entails and the competencies that are required by the general staff and managerial level to be able to face their adaptability.

In the third phase, the literature allows to know the role, functions, factors and above all the skills of the personnel in the areas of operational management and that support to generate the adaptability to Industry 4.0 in the organization.

During the first three phases, information was collected from the literature, that is, through articles, books and reports, as well as conferences and news from the web. These resources came from different countries such as Canada, China, Colombia, Spain, United States, Hungary, Malaysia, Mexico, New Zealand, United Kingdom, Czech Republic and Switzerland. Also these resources were located in platforms like ProQuest, Ebsco Host, Scopus, Emerald Insight, Cambridge Journals, Science Direct and Springer.

In the fourth phase, a survey was designed to add relevant information to the study of current managers of the first level operating areas of the Nuevo León automotive cluster. Table 2 shows how the qualitative survey was composed. The instrument for the qualitative study was approved by Dr. Joel Mendoza, doctoral professor at the Autonomous University of Nuevo Leon; And by Engineer Alejandro Elizondo, with MBA at Stanford and actual director of supply chain management.

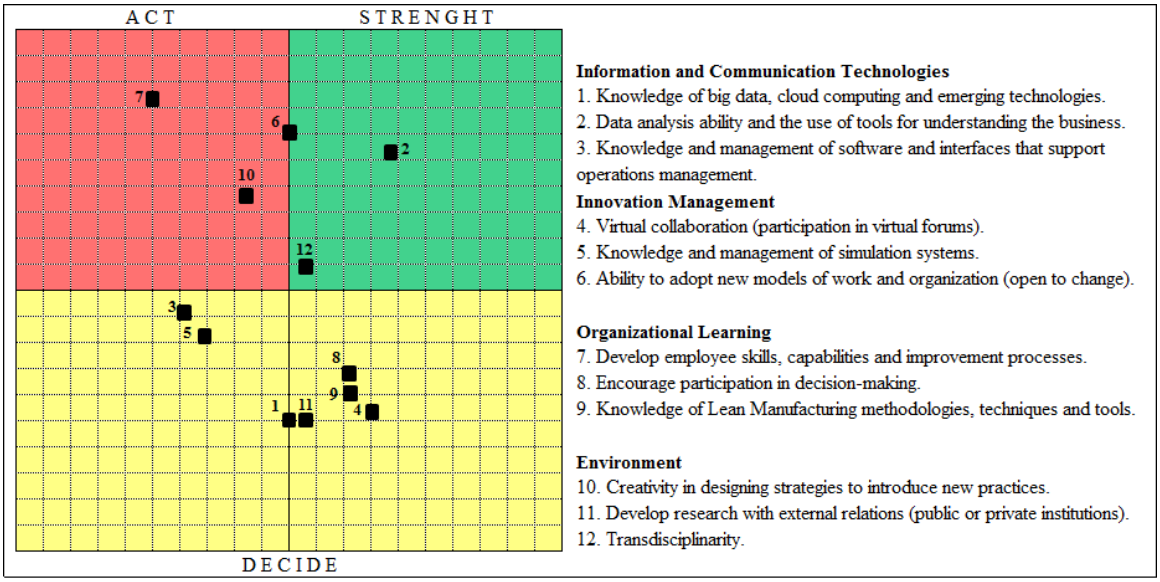
Table 2. Qualitative study survey

Dimension		Competencies	Questions
1	Information and Communication Technologies	- Knowledge of big data, cloud computing and emerging technologies. - Data analysis ability and the use of tools for understanding the business. - Knowledge and management of software and interfaces that support operations management (resources, people, production).	**1.** Order from 1 to 3 the following competences according to the importance that these have in function so that you can successfully face your management in Industry 4.0, being 1 the most important and 3 the least important. **2.** Order from 1 to 3 the following competencies with greater area of opportunity to develop in the Automotive Industry of Nuevo León, 1 being the most opportunity and 3 the least opportunity. **3.** What strategies would you implement to develop competencies with greater area of opportunity? **4.** Do you consider any additional competence to those already mentioned, to adopt Industry 4.0?
2	Innovation Management	- Virtual collaboration (participation in virtual forums). - Knowledge and management of simulation systems. - Ability to adopt new models of work and organization (open to change).	
3	Organizational Learning	- Develop employee skills, capabilities and improvement processes. - Encourage participation in decision-making. - Knowledge of Lean Manufacturing methodologies, techniques and tools.	
4	Environment	- Creativity in designing strategies to introduce new practices. - Develop research with external relations (public or private institutions). - Transdisciplinarity.	

In the design of the measuring instrument it was important to identify the relationship between all the competencies of the five dimensions that are illustrated in table 1, the finding made up of several authors. These findings were the basis for the design of the instrument. After several designs have been made, the optimum as shown in table 2 is made up of four dimensions, each conforming to three relevant competencies.

In the fifth phase, as a result of the elaboration of the previous phases, a competency model for the adaptation to the industry 4.0. The final result of the qualitative study is shown in figure 2 below.

Figure 2. Model of competencies to adopt Industry 4.0



The model used was based on the principles of performance and potential matrix, which allows in a simple way to visualize in this case, the competencies that the automotive cluster will need to focus on to reinforce and remove in which to make decisions.

The model shows the competitions classified by colors, where the red color means to take action, the green represents the strength and the yellow make decision.

4. Results

Surveys were answered by 15 managers from the area of operations, where 13% women and 87% men participated in the following positions: plant, logistics, quality and operations managers. Where 60% of them with master's degree as maximum reached and 40% only with studies of bachelor's degree in engineering.

Tabla 3. Qualitative study results

Dimension	Competencies	SCORE			GAP			
		Importance	Opportunity	Strength	Maximum Importance	Strength Score	GAP	% GAP
1	1. Knowledge of big data, cloud computing and emerging technologies.	1.50	2.00	2.00	4.50	3.00	1.50	26%
	2. Data analysis ability and the use of tools for understanding the business	2.56	1.63	2.37	7.69	6.07	1.61	28%
	3. Knowledge and management of software and interfaces that support operations management (resources, people, production).	1.94	2.38	1.65	5.81	3.20	2.62	**46%**
2	4. Virtual collaboration (participation in virtual forums).	1.56	1.69	2.31	4.69	3.61	1.08	18%
	5. Knowledge and management of simulation systems.	1.81	2.31	1.68	5.44	3.05	2.39	39%
	6. Ability to adopt new models of work and organization (open to change	2.63	2.00	2.00	7.88	5.25	2.63	**43%**
3	7. Develop employee skills, capabilities and improvement processes.	2.75	2.50	1.50	8.25	4.13	4.13	**63%**
	8. Encourage participation in decision-making.	1.69	1.75	2.25	5.06	3.80	1.27	19%
	9. Knowledge of Lean Manufacturing methodologies, techniques and tools	1.56	1.75	2.25	4.69	3.52	1.17	18%
4	10. Creativity in designing strategies to introduce new practices.	2.38	2.13	1.87	7.13	4.44	2.68	**44%**
	11. Develop research with external relations (public or private institution	1.50	1.94	2.06	4.50	3.09	1.41	23%
	12. Transdisciplinarity.	2.13	1.94	2.06	6.38	4.38	2.00	33%

The table 3 shows the score obtained by each competency, it is easy to identify the competition 7, which the automotive cluster considers the weakest, and agree that it is the most important, shows a percentage of 63% to reach its success, it means that it is in which they must work in developing to reach to adopt the industry 4.0, this competency it is about Organizational Learning dimension.

In the results of the qualitative study, in order of dimension from 1 to 4, the following areas of competence were obtained as the largest area of opportunity according to the automotive cluster: 3, 6, 7 and 10, this because they are the ones of greater importance but less strength. In the quadrant 2 of Figures 3 and 6, are the competitions 2 and 12 considered by the participants as having the greatest strength.

Figure 3. Dimension 1-Information and Communication Technologies

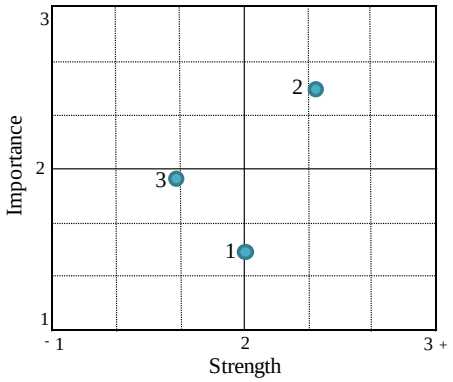
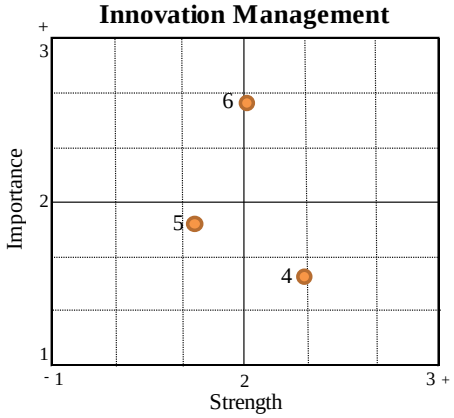


Figure 4. Dimension 2 - Innovation Management



Fgure 5. Dimension 3 - Organizational Learning

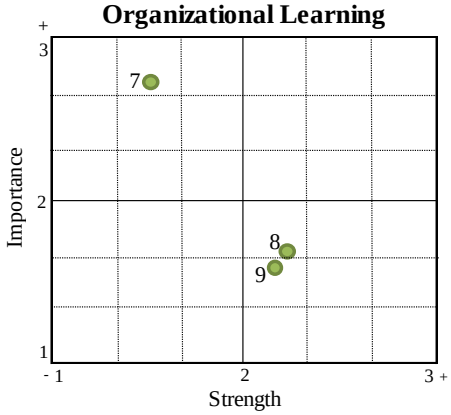
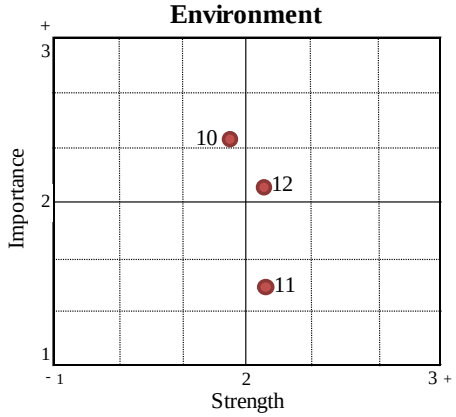


Figure 6. Dimension 4 - Environment



5. Conclusions

In the present study it has been vital to identify within the automotive cluster, from the perspective of the managers of the operational area, which are those competencies in which they require attention to develop within the companies and to be involved in this 4th industrial revolution since that has been the objective of the investigation. The qualitative study carried out within the automotive cluster of Nuevo León does not guarantee that the findings found in this research are ideal, but could contribute to the continuation of a second research where these findings are verified by means of the quantitative study.

Through the qualitative study, managers of Tier 1 companies in the automotive cluster point out with greater area of opportunity "the knowledge and management of software and interfaces that support operations management (resources, people, production)," found in the literature, was mentioned and considered relevant for the adoption of Industry 4.0 by Cuevas-Vargas, Estrada and Larios-Gómez (2016); Liu, Y., Xu, X. (2017); Li, Wang, Tao, Jiang and Chai (2010). For this dimension of information and communication technology the managers who participated in the qualitative study add as a strategy to achieve the dimension 1, incorporate training in new learning that allow the formation of new skills and the implementation of new technologies.

For dimension 2, innovation management, it is considered with greater area of opportunity the competence "knowledge and management of simulation systems", in addition to this, managers add that there should be an education about collaborative issues in a virtual way, Even consider it important to create within the company an innovation committee that is in charge of communicating new models of work and emerging technologies by this

wave of industry 4.0. In addition, a strategy that both automotive cluster and literature makes special relevance is the contribution of the government-industry-academia to develop training programs, as well as projects and research that focus on issues of Industry 4.0.

The findings obtained from dimension 3, organizational learning, about the competition will consider as more important, greater area of importance and the weaker one is "to develop in the employees skills, capacities and processes of improvement", the managers add that to develop this competition is important the contribution of the universities, to have within the curriculum the learning of certain competencies that the industry requires, and to continue strengthening the practices in lean manufacturing.

For dimension 4, competition will consider as more important, greater area of importance and weaker is "creativity in designing strategies to introduce new practices", the study allowed to know that for managers it is important to consider as a strategy the development of forums to share to good practices and other ways of doing things.

In addition to the competencies found in the present research, participants who were part of the qualitative study, consider it relevant to consider adding: (1) Financial analysis skills; (2) Leadership skills; (3) Critical and disruptive thinking.

Finally, the Universidad de Monterrey, as an educational institution, can be part of the strategies that the automotive cluster considers for Tier 1 members, contributing to courses that support new knowledge, innovation and technologies, such as use of software for resource management, simulation software among others, which employees, not just managers, require for the adoption of new practices that lead the automotive industry to the 4th industrial revolution.

References

Basl, J. (2016). The pilot survey of the industry 4.0 principles penetration in the selected Czech and Polish companies. *Journal of Systems Integration*, *7*(4), 3.

Bin Zainuddin, Y. (2017). Moderating effect of environmental turbulence on firm's technological innovation capabilities (TIC) and business performance in the automotive industry in Malaysia: A conceptual framework. In *MATEC Web of Conferences* (Vol. 90, p. 01009). EDP Sciences.

Boaz, G. (1998). Parámetros de Benchmarking para los modelos de competencias. *Training and Development Digest*, (10).

Camisón, C., & Villar-López, A. (2014). Organizational innovation as an enabler of technological innovation capabilities and firm performance. *Journal of Business Research*, *67*(1), 2891-2902.Biography

Chromjaková, F. (2016). The Key Principles of Process Manager Motivation in Production and Administration Processes in an Industrial Enterprise. *Journal of Competitiveness*, *8*(1).

Cuevas-Vargas, H., Estrada, S., & Larios-Gómez, E. (2016). The effects of ICTs as innovation facilitators for a greater business performance. Evidence from Mexico. *Procedia Computer Science*, *91*, 47-56.

Dasgupta, M. (2012). Conceptual Paper. *Sage Open*, 2158244011432198.

Davies, A., Fidler, D., & Gorbis, M. (2011). Future work skills 2020. *Institute for the Future for University of Phoenix Research Institute*, *540*.

Fonseca, C. (16 de Enero de 2017). World Economic Forum. Recuperado el 30 de Enero de 2017, de World Economic Forum: https://www.weforum.org/es/agenda/2017/01/en-la-cuarta-revolucion-industrial-se-solicitan-habilidades-complejas-en-ambitos-caoticos/

Franco, A. B., & Pulido Morán, A. (2016). *La Industria Automotriz Mexicana: situación atual, retos y oportunidades.* Ciudad de México: ProMéxico.

Gabriel, M., & Pessl, E. (2016). Industry 4.0 and Sustainability Impacts: critical discussion of sustainability aspects with a special focus on future of work and ecological consequences. *Annals of the Faculty of Engineering Hunedoara*, *14*(2), 131.

Gardner, H. Inteligencias múltiples. La teoría en la práctica (1993).

General Electric Compañía. (6 de Marzo de 2016). GE reporte Latinoamérica. Recuperado el 29 de Enero de 2017, de http://www.gereportslatinoamerica.com/post/140393477241/barometro-global-de-innovacion-ge

Gómez Díaz, M. D. R. (2016). Modelo estrátegico de aprendizaje organizacional para impulsar la competitividad municipal. *Revista científica Pensamiento y Gestión*, (40).

Gutiérrez, E. (2010). Competencias gerenciales. *Habilidades conocimientos y aptitudes. Ecoe ediciones. Bogotá Colombia*.

Jack, C., Anderson, D., & Connolly, N. (2014). Innovation and skills: implications for the agri-food sector. *Education+ Training*, *56*(4), 271-286.

Kor, Y. Y., & Mesko, A. 2013. Dynamic managerial capabilities: Configuration and orchestration of top executives capabilities and the firm's dominant logic. *Strategic Management Journal*, 34: 233-244.

Li, B. H., Zhang, L., Wang, S. L., Tao, F., Cao, J. W., Jiang, X. D., ... & Chai, X. D. (2010). Cloud manufacturing: a new service-oriented networked manufacturing model. *Computer integrated manufacturing systems*, *16*(1), 1-7.

Liu, Y., & Xu, X. (2017). Industry 4.0 and Cloud Manufacturing: A Comparative Analysis. *Journal of Manufacturing Science and Engineering*, *139*(3), 034701.

Lorentz, M., Rüsmann, M., Strack, R., Lueth, K. L., & Bolle, M. (2015). Man and Machine in Industry 4.0: How Will Technology Transform the industrial Workforce Through 2025? *The Boston Consulting Group.*

Pavitt, K. (1984). *Sectoral patterns of technical change: towards a taxonomy and a theory. Research policy*, 13(6), 343-373.

Porter, M. E. (1998). *Competitive Strategy: Techniques for Analyzing Industries and Competitors*. New York: The Free Press.

Preciado, A. (2006). Modelo de evaluación por competencias laborales. *México, DF: Universidad Panamericana Publicaciones Cruz O.*

Ruiz-Jiménez, J. M., & del Mar Fuentes-Fuentes, M. (2016). Management capabilities, innovation, and gender diversity in the top management team: An empirical analysis in technology-based SMEs. *BRQ Business Research Quarterly*, *19*(2), 107-121.

Tamás, P., & Illés, B. (2016). Process Improvement Trends for Manufacturing Systems in Industry 4.0. *Academic Journal of Manufacturing Engineering*, *14*(4).

Tidd, J. (2000). From knowledge management to strategic competencies: Measures of technological. *Market and Organizational Innovation*.

Uhrin, Á., Bruque-Cámara, S., & Moyano-Fuentes, J. (2017). Lean production, workforce development and operational performance. *Management Decision*, *55*(1).

Valadez, G. V., & Jurado, J. S. (2016). *Innovación tecnológica: un análisis del crecimiento económico en México (2002-2012: proyección a 2018)*. Análisis Económico, 31(78), 145-170.

World Economic Forum. (2016). The Global Competitiveness Report 2016-2017. Ginebra: World Economic Forum.

Milagros Díaz is currently an Academic Coordinator of Engineering Management Bachelor Academic Program in the University of Monterrey, in the state of Nuevo Leon, Mexico. In 2015 she obtained her bachelor degree of Industrial and Systems Engineering, and she is currently studying the Masters in Engineering Management from University of Monterrey, Mexico. She has participated in IEOM Conference in Orlando, Florida winning the first place with the paper entitled "Increasing Customer Service Level in Distribution Operations". Also participated Lean Challenge Spring Program in General Electric using lean manufacturing methodologies and worked as a Project Source Analyst in manufacturing companies. She was a member of ASQ association from 2011 to 2015 and was the president of the ASQ UDEM student branch in 2011.

Benito Flores is the Dean of the School of Engineering at the Universidad de Monterrey (Mexico), where he also teaches. He has been teaching in higher education institutions for 25+ years. He holds a BS in Industrial Engineering, a MS in Quality Management and a Ph.D. in Educational Administration. He is a member of associations such as ASQ, ASHE and ASEE, and serves in the Board of Directors of several non for profit organizations including the SC-Polytechnic High School (Mexico), the Southern Association of Colleges and Schools and the American Society for Quality. In 2007 he received the Roberto Garza Sada Teaching Award, the highest recognition the Universidad de Monterrey awards to its faculty. He has received national awards in Mexico for his research in student engagement and academic rigor.