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The Importance of the Managerial Abilities in the Development of Automotive Embedded Software in Mexico

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Abstract: Computers have transformed our lives; they have changed the way the humans perceive and interact with the world; however, computers do not act by their own, all of them require of commands to work, called software. Creating software requires trained and specialized personnel in the field, such as Managers, which must have skills that allow them to successfully coordinate the development of projects. This research aims to show the abilities that senior management has and which of these are more frequently exhibit in companies that develop automotive embedded software in Mexico, all this in the opinion of the Project Leaders.

Keywords: Automotive Software, Embedded Software, Manager Abilities

I.   INTRODUCTION

Through time, computers have transformed our lives without being fully aware of it; they have changed the way the humans perceive and interact with the world; however, computers do not act by their own, all of them, since they first showed up in the mid-twentieth century, require of commands to work, called software.

There are different types of software; one of them is installed on laptops and it is called "desktop software", another one resides in tiny microcontroller chips called "embedded software". The latter is found in very diverse devices that are used every day, such as the cell phones, tablets, cameras, televisions, ATMs and even in automobiles, which are known as a whole as embedded systems.

Marwedel (2003) referenced by González and Urrego (2008) describes an embedded system as a specific information processing system integrated into another system of larger size and made up of hardware and software components.

Systems and devices that use embedded software are so popular nowadays that they are produced inincreasingly larger quantities and therefore require more and better software creation.

Its development exhibits great challenges due to its particularities. Customers of these systems want toobtain characteristics such as high degree of reuse, maintainability and flexibility. The possibility of combining all these attributes presents software engineering difficulties, all this in the search for higher levels of abstraction in the development of embedded software (Hernández, 2010).

The software development went from being essentially an artisanal work to a joint work effort, where each person must not only perform his or her role correctly, but must function as an effective member of the team (André, Baldoquin de la Peña and Soler, 2007).

That is why creating embedded software requires trained and specialized personnel in the field. This staff is made up of designers, coders, project managers and managers. The latter of them, managers, have activities that tend to be fragmented and varied; they handle conversations that are disjointed and their important tasks intermingle with other that are trivial (Yukl, 1998), for that reason they must have skills that allow them to successfully coordinate the development of projects by their work team; their role inthe area of software is so vast that it can range from technical and administrative guidance, to the creation of an environment conducive to the proper execution of the activities.

According to Pressman (2004), referenced in the work of André, et al (2007), it is significant the number of software projects that do not end up with success, being one of the causes of such failure those associated with human factors.

However, it should be noted that not all the skills of the manager cause the same effect in the achievement of results; currently, embedded software projects are so complex that they are subject to very different conditions, which shape the performance of the participants, especially those who are responsible for coordinating the work of others.

This research aims to find the abilities that senior management has and which of these are more frequently shown in companies that develop automotive embedded software in Mexico, all this in the opinion of the people who are closest to the managers, which are the Project Leaders.

On the basis of an exhaustive review of literature and investigations, it was created Table 1 with a comprehensive list of Managerial abilities, 25 in total, that were grouped by the categories identified in an analysis performed by the USDA (United States Department of Agriculture).

Table 1. Groups of managerial abilities.

Managing Self	Managing Projects	Managing People	Leading Organizations
Respect	Team Management	People Management	Entrepreneurship
Persistence	Leadership	Empowerment	Executive Leadership
Self-learning	Problem Solving	Coaching	Change Envisioning
Proactivity	Quality Focus	Role Model	Strategic Vision
Accountability	Technical Expertise	Collaboration	Customer-centricity
Loyalty	Results Oriented	Effective	Decision Making
Creativity			

II. THEORETICAL FRAMEWORK

Modern companies are constantly changing in an effort to improve their internal operations to be more competitive in the marketplace, while striving to optimize all their available resources to take advantage of new opportunities (Karnouskos, 2015).

They have had to evolve at an accelerated pace according to the expectations of productivity, competitiveness and efficiency, and within the organization all employees regardless of the organizational hierarchy are responsible and vital in that goal. The essence of winning or failing is the interrelation between levels and the sum of their results.

In this sense, the organization implies an intentional and formalized structure of functions or roles (Koontz and Weihrich, 2004).

In a previous study of management practices, Mintzberg, (1990) describes an extended catalog of administrative functions. The results obtained lead to the identification of ten specific management tasks, which in turn are divided into three categories:

- **Interpersonal:** related to how the management, as the head of the organization, interacts with contacts within and outside the company.
- **Informative:** or how management exchanges and processes information between the different levels of the organization, as well as outside of it.
- **Decision:** in which the management is defined as a group dedicated to make decisions and use its authority to represent the interests of the organization.

However, just as relevant as the functions of Senior Management are the abilities that they demonstrate with their workers and, even when the terms "functions" and "abilities" can be used indistinctly, abilities must be understood as: "the capacity to adequately perform certain physical and mental tasks" (Alles,2009: 287); whereas, function is an activity or set of activities.

The abilities are more on the behavioral side of the human being and motivate certain actions in response to specific circumstances. The abilities are the most important intellectual asset that managers possess and an essential key of success; they tend to be visible characteristics of people and are on the surface of their personality (Alles, 2009).

More than 60 years ago, Katz explains in Skills of an effective administrator the abilities that must be present in all operational levels of the organization, understanding them as part of the behavior of the individual.

Katz mentions that the success of a manager depends, above all things, on its performance, according to the personality characteristics; being the performance a result of the abilities (Chiavenato, 2006).

According to Katz there are three fundamental abilities for successful administrative and management performance: technical, human and conceptual.

- **Technical abilities:** are related to doing and to manipulate objects to generate something.
- **Human abilities:** they relate to the interaction with people and the easiness to create interpersonal and group relationships, for example communication and motivation.
- **Conceptual abilities:** they relate to thinking, reasoning and diagnosing the situations that allow planning for the future.

As the hierarchical scale of the organization grows, the composition of these three abilities very as a consequence of the responsibility and challenges of the work. That is, at the lower levels the supervisor largely relies on the technical abilities to deal with the different operational problems of the day to day; while, on the other hand, Top Management is minimally dependent on the technicalities to make room for the conceptual abilities, that allow to establish the mission, the vision and steer the course of action of the company.

For Ortiz and Arredondo (2014) the manager must be alert and willing to act with the dynamism of the market, as well as being well informed about the environmental trends, since their ability to anticipate changes may be their most valuable competence. In an article issued in the Harvard Business Review magazine, the authors Fernández-Aráoz, Groysberg and Nohria (2011) describe a model of the elements that comprise the executive potential, where "potential" is understood as an indication of whether someone will be able to succeed in a corporate role.

This model summarizes the elements that the modern company must identify in its staff in order to manage and retain their best candidates for management positions.

The model contains five elements that are shown in an equal number of concentric circles that vary from very difficult to easy to change. In the center of the model are the motivations of the managers, which are directly related to the activities that they like to perform and are interesting for them. At the next level are leadership skills, such as the ability to influence others, the discernment and intuition to understand large amounts of information and transform it into guidelines, new experiences and ideas. Subsequently the sense of identity and self-visualization surrounded from its personality traits to the abilities, which is what the executive can and is able to do. The last circle represents the knowledge, which should not be confused with abilities either (Fernández-Aráoz, et al, 2011).

The profile of the manager is one of the core elements of business success, as well as the collaboration links that this can generate, knowledge of the market, innovation, technology and administrative management (Ortiz and Arredondo, 2014).

At the same time, Patterson (2010) comments that because all organizations depend on an effective administration to survive and prosper, the training of people in managerial positions must be done with great care. That is why it is important to highlight that the best candidates for leaders can be identified, because they follow certain guidelines of personality and behavior; hence, the relevance of uncovering the most significant abilities that promote success from others that could be secondary. On the other hand, the abilities obey to situational events, which are defined, observable and tangible at a certain moment.

Stewart (1982) identified three situational aspects called: demands, restrictions and choices, which shapethe nature of the manager work and strongly influence its behavior and acts.

He called demands to the expectations that any person of the organization must accomplish (objectives, due dates, responsibilities, etc); restrictions to the characteristics of the organization and the external environment that limit what the manager can do (for example, the availability of human resources, budget, use of technology, facilities location) and choices to the activities that a manager performs without feeling compelled to do so (business opportunities, flexibility of operation, among others).

Regarding the restrictions, Ocaña (2013) points out four major limitations in the realization of projects: scope, time, cost and quality, and determines that the success or failure of the projects mainly depends on the daily decision-making, since they keep the project progressing and, if necessary, redirect it to the initially defined plan. In addition, Rodriguez,

Garcia and Lamarca (2011) add that the support of the management in items such as authority, consistency and provision of resources, is one of the elements that ensure the success of a project.

Gallego and Hernández (2015) come to a similar conclusion, indicating that the achievement of software projects converge to three main principles, which are time, cost and quality; nevertheless, it is necessary to pay attention to other elements that are also fundamental to fulfill the goal.

A more detailed research done by Van der Westhuizen and Fitzgerald (2005) shows that the determination of the success of a project is made up of a series of variables divided into two main groups: success in the administration of the project and the success of the product, as it can be seen in Fig. 1.
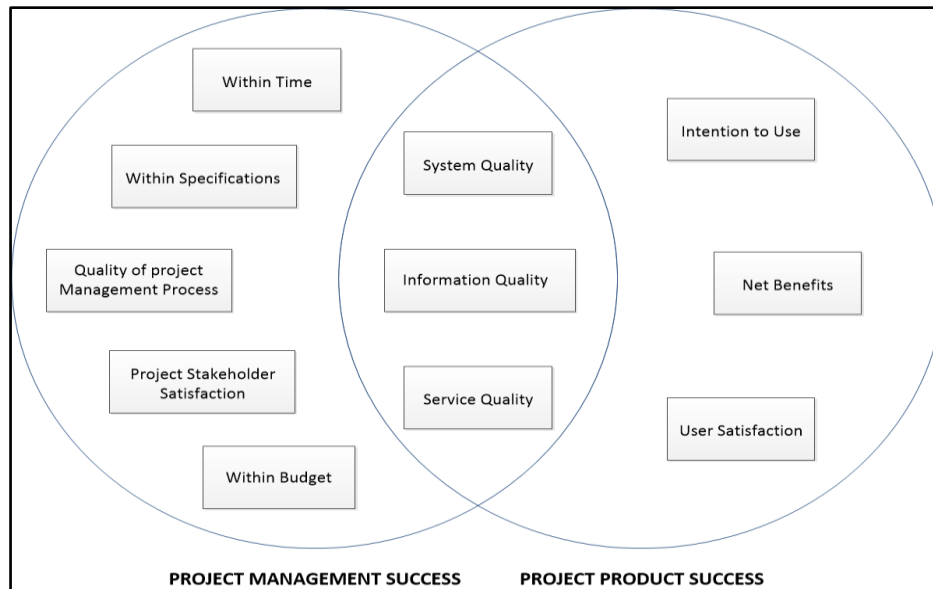

Figure 1. Variables that determine the success of a project.

The first group approaches the efficiency in the execution of the project, focused mainly on cost, time and quality. The second group is aimed at determining the acceptance and effects of the final product in the consumer. Therefore, in general terms, a project is successful when both groups have satisfactory results.

At this point it is imperative to frame the particularities of the executive from a geographical stand point,in order to understand the relevance of top management in the successful execution of projects in Mexico. Previously, it was addressed the fact that management abilities come as a result of the environment where these are developed and the circumstances that lead to their execution; it is then obvious to think that the management role and the competencies that it owns change from one geography to another.

Given that a unique business model does not exist, the abilities of a person in a given position are defined by its personality and behavior, and these abilities are preceded before anything else by the cultural characteristics typical of the nationality or race. The culture has an important influence in the administration, the decision making process and the negotiations, it alters the way strategic plans are handled and presented, and can even facilitate or hinder the execution of an international project.

Managers who consider starting a business abroad, involving employees of other nationalities, should pay close attention to the cultural differences.

Nowadays, in the world of business, organizational culture, understood as the accumulation of values, interactions, behaviors, and habits, depends on the criteria used by the company to manage its business, as well as the culture that represents to its members (Dicu A., Neghira C., Oprea A. and Vasileva T., 2009).

A Mexican manager will, therefore, perform its functions in a manner unlike to that of its colleagues in other latitudes, and even more, a foreign manager in Mexico would perform its work also in a different way than it would in its country of origin, by the simple fact of the interaction with national's citizens.

The research made by the Dutch psychologist and anthropologist Geert Hofstede is a referent to understand more clearly the cultural peculiarities of any country.

In Hofstede's five-dimensional model, an equal number of cultural dimensions are evaluated by country and thus obtain, if desired, a comparative score. Model is shown in Table 2.

Table 2.Dimensional model by Hofstede.

Cultural Dimension	Definition	The higher the score...	The lower the score...
Power distance index **(PDI)**	It expresses the degree to which the less powerful members of a society accept and expect that power is distributed unequally	More inequality and expectations that some individuals will have much more power than others	People strive to equalize the distribution of power and perspective that people should have equal rights
Individualism **(IDV)**	Degree to which individuals are integrated into groups or self-reliant	More individualism and self-determination	More collectivism and importance to family and group ties
Masculinity **(MAS)**	It is the value assigned to the distribution of roles between genders	Preference for achievement, assertiveness and competitiveness	Preference for modesty, expressions of affection and care to others
Uncertainty avoidance index **(UAI)**	It reflects the degree of tolerance to uncertainty and ambiguity	More evasion to risk, unknown and unusual situations	More tolerance to risk and opinions
Long-term orientation **(LTO)**	Indicates the importance given in a culture to the planning of life in the long term in contrast to the immediate concerns	More long-term orientation and tenacity to achieve goals in the future	More short-termism and the need to obtain fast rewards

The adoption of the Hofstede model in the case of Mexico and its use in the management of companies and projects yields to the results in Table 3.

Table 3.Dimensional model score for Mexico.

Dimension	Score	Implications for management
PDI	One of the highest in the world, with 81	• Inequities expected between organizational hierarchies • Centralization of power and decision making • Wide salary ranges • Subordinates expect to be told what to do • Existence of autocratic leadership
IDV	Bottom of the table of studied countries, with 30	• Team-based administration • Human relations prevail over tasks • The recognition is directed more to the team than to the individuals • Promotions depend more on the seniority and experience of the person • Need to be sociable
MAS	One of the highest in the world, with 69	• The dominant values are material success and progress • High competitiveness at work • Managers are expected to be decisive and assertive
UAI	Top of the table of studied countries, with 82	• Existence of work stress and anxiety • Need for strict rules and policies • Resistance to innovation and risk-taking • Motivation caused by job security • Low motivation caused by achievements • Scarce work creativity • High level of perseverance

LTO	One of the lowest in the world, with 24	• Normative work culture • Strong concern with establishing the absolute truth • Normative thinking • Focus on achieving quick results

The results of this model can be explained in several ways; Hofstede's detractors claim that the diversity of a country cannot be derived by a few variables; this could be true, however the purpose of bringing it up is to make it clear that the analysis that motivates this work must, without a doubt, consider the case of the Mexican manager and that none previously made in other countries can be applied directly without adapting it to the national environment.

III. METHOD

The research was non-experimental, transactional and correlational-causal. The correlational-causal part would allow to establish what the relationship is between the evaluation of the Senior Management abilities based on variables such as: experience of the leaders, number of worked projects, duration of theprojects and number of participants.

Galindo (1998) and Hernández, et al. (2010) point out that for this type of research the most adequate methodology to gather information that would make possible to obtain conclusions, is the application of surveys to multiple individuals. The attributes required of the surveyed subjects were:

- Have a position of project leader or similar, in the areas of Systems Engineering, Software Development or Software Testing.
- Have studied engineering in systems, electrical, electronic or similar field.
- Work in a company dedicated to the development of embedded software projects for the automotive industry in Mexico.
- The company should reside in Mexican territory, regardless of whether it was of foreign origin or had its headquarters abroad.

Prior to the launch of the survey, a description of the individuals was made according to some of their characteristics. This was done with the purpose of dividing the population of respondents according to their engineering level. This categorization would allow to evaluate if the survey was homogeneously answered by engineers of different experience and the weight of this in the evaluation of its Management.

The characteristics that were taken into consideration to create the engineering levels were seniority in the position of leader, the number of projects in which he/she has worked, the average duration of the projects and the average size of the work teams, see Table 4. These categories were named with common denominators used in the area of engineering: Junior, Advanced and Senior.

Table 4. Engineering Levels Characteristics.

	Experience			
	Seniority in the position	Number of projects	Average duration of the projects	Average size of work teams
Junior	1 – 5 years	1 – 10 projects	More than 24 months	1 – 5 participants
Advanced	6 – 10 years	11 – 20 projects	13 – 24 months	6 – 10 participants
Senior	More than 10 years	More than 20 projects	1 – 12 months	More than 10 participants

Regarding to the population of companies that met the criteria to be considered, 6 were found in various areas of the Mexican territory, nevertheless engineers from only 5 of them were consulted due to the feasibility to reach their members and obtain information through them. The company products, all of them automotive, varied from audio systems and electric seats to gasoline pumps and engine control modules.

Due to the nature of the research it was decided that the surveyed sample should be probabilistic and random, in which all the elements of the population have the same likelihood of being chosen (Hernández, et al, 2010).

The size of the sample was calculated with the following formula, resulting that the total number of respondents should be at least 83.

Finally, the survey encouraged the participants to evaluate 50 statements -two for every one of the 25management abilities found- using a Likert scale from 1 to 7; where 1 represented "strongly disagree" and7 "strongly agree".

In order to find out the reliability of the measuring instrument, the Cronbach's Alpha was applied to the data from the surveys.

As shown in Table 5, the coefficient obtained through the use of the statistical software package SPSS forthe groups of abilities was on average greater than 0.95, which can be interpreted as high reliability and validity in the instrument.

Table 5. Cronbach's Alpha calculation per group of abilities.

Managing Self	Managing Projects	Managing People	Leading Organizations	Average
0.96	0.95	0.94	0.95	0.95

In order to complete the field work, the gathered data was also processed and analyzed with the statistical program SPSS; this was done with the purpose of achieving the following objectives:

General Objective
● Identify the most developed abilities that Senior Management has, based on the assessment of the Project Leaders of embedded software with application to the automotive sector in Mexico.

Specific Objectives
● Determine the relationship between the evaluation of the abilities given by the Project Leaders and their different engineering levels.

For the objectives above, the following hypotheses were proposed:

Hypothesis 1: The group of abilities of Managing Projects is the most developed of all the groups that were evaluated for the senior management.

Hypothesis 2: Project Leaders with engineering level of Advanced gave the lowest evaluation to the senior management of their company.

IV. RESULTS

Thoroughly analyzing the data of the 83 respondents, it was observed that regarding the level of engineering, 13 or 16% had a level of Senior, 30 or 36% were Advanced and 40 or 48% were Junior.

The information was also examined by ability group. The four radar charts shown below belong to this data. These graphs allow to easily and visually identify what are the most prominent areas of opportunity in relation to the abilities.

Fig. 2 corresponds to the group of abilities of **Managing Self**. In this graphic can be seen a very large difference between the best qualified ability (Loyalty) and the worst rated (Creativity). In the end it was observed that "Loyalty" was the second highest rating among all the abilities, while "Creativity" had the second lowest.

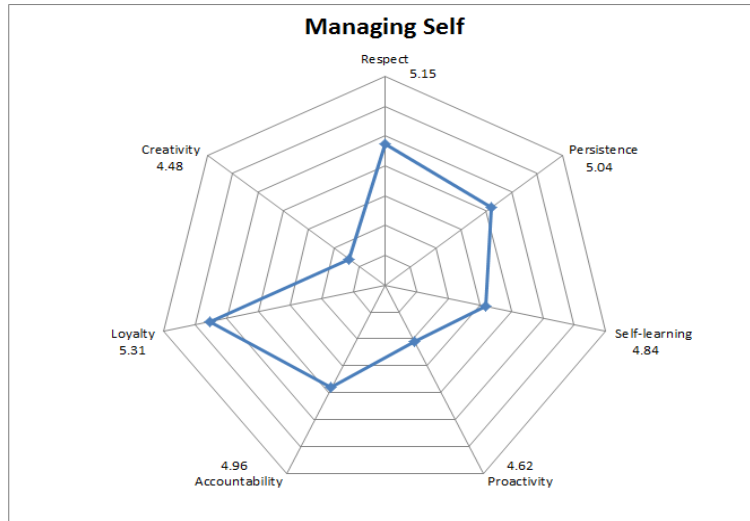This group obtained the second highest standard deviation, with a value of 0.29.

Figure 2.Evaluation of abilities in Managing Self group.

Below, in Fig. 3, is the **Managing Projects** abilities group. It is easily visible that the radar shows apolygon close to being hexagonal. This group was the most homogeneous of all with a standard deviation of 0.08.

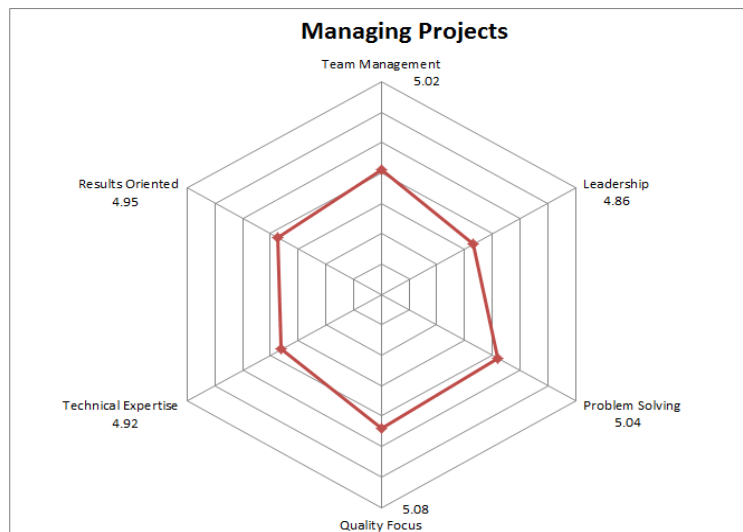Also, it is the group of abilities that, on average, obtained the highest rating.

Figure 3.Evaluation of abilities in Managing Projects group

Fig. 4 belongs to the **Managing People** abilities group. In this group, the "People Management" ability stands out with the fifth worst rating of all the abilities evaluated (4.68).
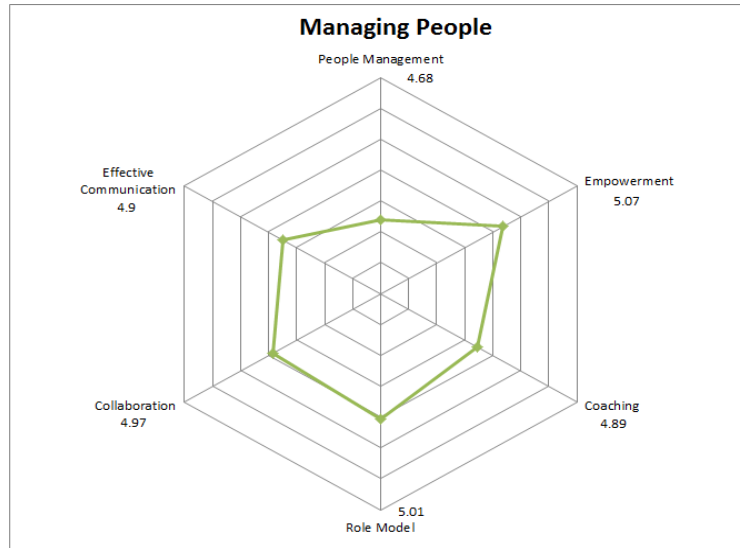
Figure 4.Evaluation of abilities in Managing People group.

Lastly, in Fig. 5 is shown the abilities group of **Leading Organizations**, which is the most heterogeneous group, its standard deviation is 0.37.

This includes the highest and lowest qualification of all assessed abilities, "Customer-centricity" and "Strategic Vision" respectively.
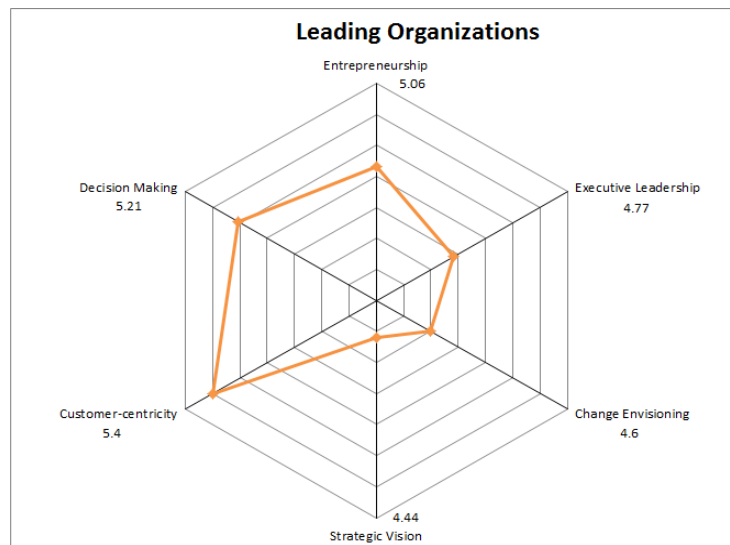

Figure 5.Evaluation of abilities in Leading Organizations group.

With regards to the average of the groups of abilities, it is observed in Fig. 6 that the **Managing Projects** group was the highest evaluated and therefore it is comprised of the most developed abilities, in opinion of the Project Leaders.

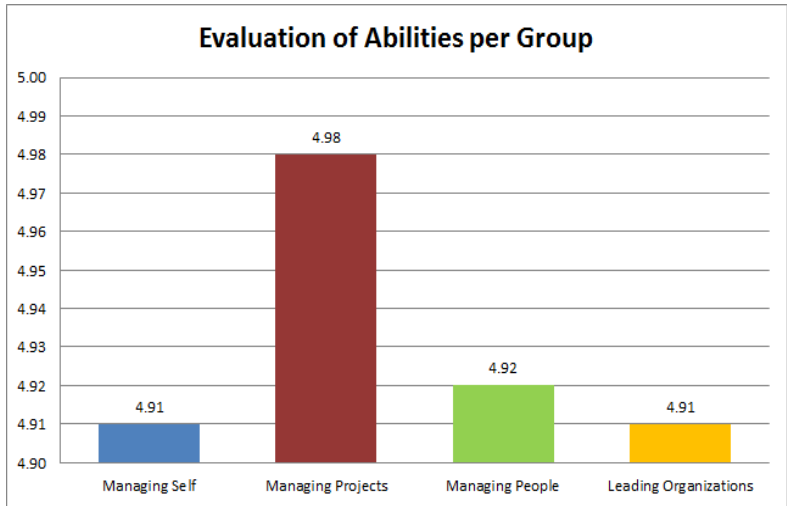The rest of the groups exhibit very close scores with one another.

Figure 6.Average evaluation of all abilities groups.

Although it may not be statistically significant, the average data from the group of abilities allows to accept the first of the hypothesis raised. Specifically, the **Managing Projects** abilities group got the slightly highest rating.

Concerning to the second hypothesis of this investigation, by assessing the collected data now from the engineering level standpoint, it can be concluded that the **Advanced** engineers gave the lowest score to their management, followed by the Senior engineers; while the Junior level sees with more benevolence their performance, as shown in the Table 6.

Therefore, the hypothesis is confirmed and accepted.

Table 6. Evaluation of abilities per engineering level.

Junior Engineers	Advanced Engineers	Senior Engineers
5.10	4.73	4.87

V.   CONCLUSIONS

The effects that human factors have on the development and success of embedded software projects are a barely researched topic, which several authors agree with. There are no work processes or models that consider the abilities required to play a role as relevant as that of Senior Management in this area of the industry.

Companies that make of the software creation their livelihood are eager to know what are the skills that they can use, as well as those that still need to improve and foster, because they are aware that these give them a competitive advantage.

Therefore, this research brings up several conclusions that are listed below.

The scores given to the Senior Management abilities are low in general; this shows a worrying reality, for example the ability of "Strategic Vision" registers the lowest evaluation, closely followed by others that are transcendental to direct companies towards a process of constant renovation, positioning and adaptation, such as "Change Envisioning", "Creativity" and "Proactivity".

For an industry that relies so tightly on technology and moves throughout accelerated changes every day, having deficiencies in such relevant abilities compromises the prospect of having a place of long-term excellence.

As mentioned by Ortiz and Arredondo (2014), the administrator needs to display at all times his willingness to assume and understand the constant changes in the industry, while acting accordingly, having an open continuous improvement attitude given the external demands .

A potential cause of the low rates of these abilities is that the actions of these companies, instead of autonomous, depend heavily on the companies from which they derive or the clients for whom they work, so that their structure is designed to meet their needs and adopt their guidelines. Hence, the ability with the highest score was "Customer Focus".

Another finding is the slightly higher development that the surveyed companies have achieved in the **Managing Projects** related abilities. These abilities have allowed them to perform successfully in their field of action, since they have concentrated on carrying out specific tasks.

The mastery of these abilities, in most cases, is the difference between staying or disappearing in an industry that faces a period of expansion and high competition.

On the other hand, the group of abilities of **Managing Projects** got the most homogeneous scores, with no ability standing out significantly more than the others, which contrasts markedly with the gap observed in the other groups. This leads to infer that the members of the organization know the importance of successfully project development and pay equal attention to the abilities that make it possible.

Regarding the evaluations of the abilities by engineering levels, it is noted that the Project Leaders who awarded the lowest grades to Senior Management are at the **Advanced** level.

One reason that explains this result is the fact that **advanced** engineers demand more development opportunities, are less aware of the working conditions, and are in the process of creating loyalty and identity with their company.

The above data allow us to affirm that the automotive embedded software sector in Mexico requires urgent work to improve the labor skills of its members in the most influential positions, given that they are the ones who guide the organization and give certainty to their future.

These are moments of boom in the area and it is necessary to take the definitive steps for its consolidation. Mexico already has a generation of professionals with proven capability, along with a new wave of engineers who are trained on the newest and most advanced of the subject. The mix between the knowledge of the most "experienced" and the dynamism of the "young" would be a great push forward.

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