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# Management of the Technological Innovation Process in Software Companies from Sinaloa, Mexico

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***Abstract****. The objective of this paper is to explain the management process of technological innovation within certified software companies from Sinaloa, considering their strategic technology plan, innovative processes, and intellectual capital. This work is based on the study of 9 software companies located in Sinaloa and certified through the CMMI (Capability Maturity Model for Integration) process. Their problems are grouped into three areas: 1) strategic technology plan, 2) innovation and 3) intellectual capital. We propose a model of innovation management to explain and evaluate the integration of those three areas applying a mixed methodology, theoretical foundations, and the analysis of the results. The overall results reveal that the certified software companies from Sinaloa manage innovation informally, through an internal, costly and independent innovation process without considering alliances with other companies, educational institutions, government agencies, technology parks or research and development centers.*

***Keywords:*** *innovation management; software companies; technology.*

## Introduction

The development of software has become an innovative economic activity for technology related products and services that stimulate innovation in almost all economic sectors. As a very dynamic sector, companies are required to produce new and better products and services at lower costs. In order to accomplish this, successful firms invest in research, development and innovation (R+D+I) activities. They leverage modern IT infrastructure,

hire entrepreneurial minded people, as well as highly skilled, English proficient human capital. They have built a network of business partners, have a good reputation throughout international markets and have adopted management models to boost competitiveness and quality.

Therefore, the success of these companies greatly depends on their strategic management approach; which means solid implementation of innovative processes and recruiting highly skilled personnel. This compels the emerging enterprises to outline the strategy for managing innovation in order to be competitive in a demanding global market.

According to Sheasley (1997), effective management requires capable and committed managers who understand and implement essential managerial techniques. These techniques enable management of the knowledge exchange throughout the business units of the company (Dankbaar, 2003).
In order to be competitive, innovation management within the enterprise should be acknowledged as a crucial process. It is a complex series of interactions between suppliers, consumers, educational institutions, technological centers and governmental agencies. A deep understanding of how to manage innovation is vital for software companies; it allows them to identify entrepreneurial practices and determine which innovative activities to support. To the extent that these processes are known and acquired it will be possible to have better managerial tools.

How do the software companies from Sinaloa manage technology considering their strategic technology plan, innovative process and intellectual capital? Considering the approaches above, the purpose of this research is to answer that question. We propose an analytic model adapted to the cultural and organizational characteristics of the certified software companies located in the region. We will evaluate and explain the MIT (Management of Innovation and Technology) by correlating their strategic technology plans, innovative processes, and intellectual capital.

## Theoretical foundations

In mid-90s technological changes started to be addressed within a more comprehensive scope, developing a new dimension of analysis of the organizational variables: the enterprise, R&D departments, projects, products and processes. As a result of this brief evolution, a new discipline emerged, oriented to the analysis of technology management and its recognition as a key element for international competitiveness, focused on the effective design of products and processes, development and

application, which has been known as: Management of technological and innovation (Burgelman & Maidique, 1988; Roberts, 1996); Management of technological innovation (Che & Andreassi, 2011); Managing Innovation (Tidd & Bessant, 2009); Managing technological innovation (Betz, 2011); Technological innovation management (Dodgson, Gann & Salter, 2008); Innovation management and technology (Ortiz & Pedroza, 2006); Innovation management (Hidalgo & Albors, 2008); Technology Management (Medellin, 2013); and even, Direction of innovation (Nieto, 2001).

According to the postulates of Nieto (2001), in recent years, the concepts of learning and knowledge production have been used to describe the process of innovation within the organizations. For these theorists, innovation is an economic issue (Medellin, 2012); a process centered on the ability to learn and adapt (Tether, 2003); a systematic, organized, rigorous and risky discipline (Drucker, 2002) that requires high technology, market intelligence and teamwork to be managed (Sheasley, 1997), in order to allow the renovation of any organization (Tidd & Bessant, 2009).

Innovation management requires knowing the market, the technology trends and the customers; the acquisition of external technologies that are not possible to develop internally; optimize the production processes to obtain a higher efficiency through the technologies applications, among others (Aranda, Solleiro, Castañon & Henneberry, 2008).

To manage technologies, Sheasley (1997) suggests capable people and a committed manager with an understanding of the essential elements and their application. It also involves managing the exchange of knowledge among several people and departments (Dankbaar, 2003). Therefore, effective management requires the adoption of socio-technical systems that include all aspects of the organization: people, processes and technology (Adams, Bessant & Phelps, 2006).

Therefore, understanding how to successfully manage innovation is vital, as it is an inevitable strategy of survival (Ortt & Van der Duin, 2008). Thus, software companies require an administration that assumes the responsibility for achieving productivity and quality; pursuing the innovation, growth, diversity and complexity that the market demands.

For COTEC (Foundation for Technological Innovation), management is an essential practice that helps effectively direct the operations within the organizations and to strategically strengthen and develop their resources and capabilities. It represents a congruent balance between all business

functions: marketing, R&D, production and human resources management; it gives the executives the control to manage technological resources and provide them with a real and foreseen vision of the company and its potential for future development (Morin & Seurat, 1987).

Management helps organizations create a strategic vision to achieve their competitive advantages (Roberts, 1996). Therefore, managers should acquire skills and abilities to respond to the challenges and problems of research, development, production, marketing of new processes, products or services, prevention and assimilation of the impact on the operations caused by internal innovations (Medellin, 2012).

The foregoing is a process that requires a multidisciplinary approach. From Edosomwan's (1989) perspective, it integrates science, engineering and administration with research, products development and manufacturing, in order to effectively achieve the goals and operational objectives.

According to Medellin (2013), this integration requires managers and employees that understand the nature of the technologies being used, the implications of innovation in their businesses, the type of strategic and operational responses to be implemented, the operational challenges that rise with the technological changes and the requirements to compete in increasingly demanding and dynamic markets. This author states that the challenges and the ways the enterprise respond define the practical and theoretical foundation of what this work means by management of technological innovation: "Organization and management of resources, both human and financial, in order to increase the creation of new knowledge; the generation of technical ideas to obtain new products, processes and services or improve existing ones; the development of such ideas into working prototypes and transferring those same ideas to the stage of manufacture, distribution and use" (Roberts, 1996, p.53).

Due to technological change defined by the renovation and creation of new technologies, management innovation emerges as a new, highly diversified discipline that becomes more relevant from the entrepreneurial, academic and research perspectives every day. There are important multidisciplinary contributions from the literature that address this subject: sociology, history, economics and firm management. Each of those has their own but different methodologies and study subjects.

Nonetheless, despite the progress to guide the research on management of innovation, recent theoretical trends show a lack of convergence in the ideas and knowledge to approach this topic (Adams et al., 2006; Manjarres

Vega, 2012; Sing & Bernstei, 2006). Therefore, there is still no theoretical basis that could be widely accepted by the researchers.

According to Nieto (2001), that is because the managerial areas in the enterprises belatedly approached the study of the processes of domestic technological innovation, even after other approaches such as economics, sociology, psychology and history. Certainly, multidisciplinary contributions have enriched the study of business and technology management; however, Nieto (2001) states it has also hampered the consolidation of a dominant paradigm and the establishment of strong methodological and conceptual foundations of this new discipline. This situation is advantageous because it allows us to study the problem using different approaches and incorporates the advances of other disciplines (Cannella & Paetzold, 1994).

Nieto (2001) identifies three main approaches that have guided the MIT until the early 90's: 1) Operational: analyzes the direction of R&D; 2) Structure-Conduct-Performance (SCP): identifies the structural factors for innovative activities in the companies and 3) Resources: consider the strategic administration of the internal resources for the generation of knowledge.

Dankbaar (2003) presented another proposal of two different but complementary approaches:

1. Under the first approach, the contextual conditions that promote innovation are established in the organization.
2. The second approach, understands the MIT as an application of knowledge into the work of the employees who generate it.

In recent decades MIT has changed which implies that the implementation of best practices in the enterprises has also evolved (Ortt & Van der Duin, 2008). Recent investigations propose new approaches or dimensions of analysis regarding this issue, considering different business areas (Table 1).

***Table 1. Analysis Dimensions of Innovation Management***

| Author(s) | Year | Dimensions |
|---|---|---|
| Dodgson | 2000 | R+D, development of new products, commercialization of innovation, operations and production, technological collaboration and technological strategy. |
| European Foundation for Quality Management | 2005 | People, contracts and resources, customer centered, strategies and plans, leadership, ability for innovation, innovation process. |
| Adams, Bessant and | 2006 | Supplies management, projects, knowledge and |

| | | |
|---|---|---|
| Phelps | | clients, innovation strategy, culture, organizational structure and commercialization. |
| Roberts | 2007 | People, processes and plans. |
| Aranda et al. | 2008 | Clients, market, suppliers and competitors, technological and strategic planning, competitiveness, technological assets. |
| Igartua, Ganzarin and Albors | 2008 | Technology, people, culture, communication and organization. |
| Tidd and Bessant | 2009 | Market, technology and organization. |
| Foundation National Prize of Technology A.C. | 2012 | Technology supervision, technology planning, qualification of technologies and resources, protection of technological assets and the implementation of innovations. |
| Medellín | 2013 | Technological strategy, organizational structure and work styles, technology management process and technology managers. |
| Hajikarimi, Reza, Jazani and Mahdi | 2013 | Resources for innovation, innovation process and innovations. |

Despite the diverse models presented, Ortt and Van der Duin (2008) think that the analysis of the MIT suggests that innovative organizations do not follow the best practices as prescribed by the dominant model of the time, but are often based on their specific context. Moreover, Tidd and Bessant (2009) state that a successful MIT is more than just the management of a single aspect such as creativity, research and development, or the improvement of products.

Considering the previous statements and the analysis we did of the different models, we propose a framework to analyze MIT within the enterprise, based on three main aspects: 1) strategic technology plan, 2) innovative process and 3) intellectual capital; since they are essential factors with great impact on the innovative performance of the software certified companies in Sinaloa.

## Methodological approach

In order to understand the process of managing innovation and technology within the certified software companies in Sinaloa, our research applied the Mixed Methods approach of Creswell (2008). Under the assumption that a unique model that could explain the MIT in all its complexity and that could be applied to all the economic sectors does not exist yet, we suggest an specific model according to the cultural and administrative characteristics of the software companies in the state, considering: 1) their strategic

technology plan, 2) their innovative process, which are the efforts toward the generation and the implementation of innovative ideas, and 3) their intellectual capital who are the people that represent an intangible asset to drive the innovative process (Figure 1).

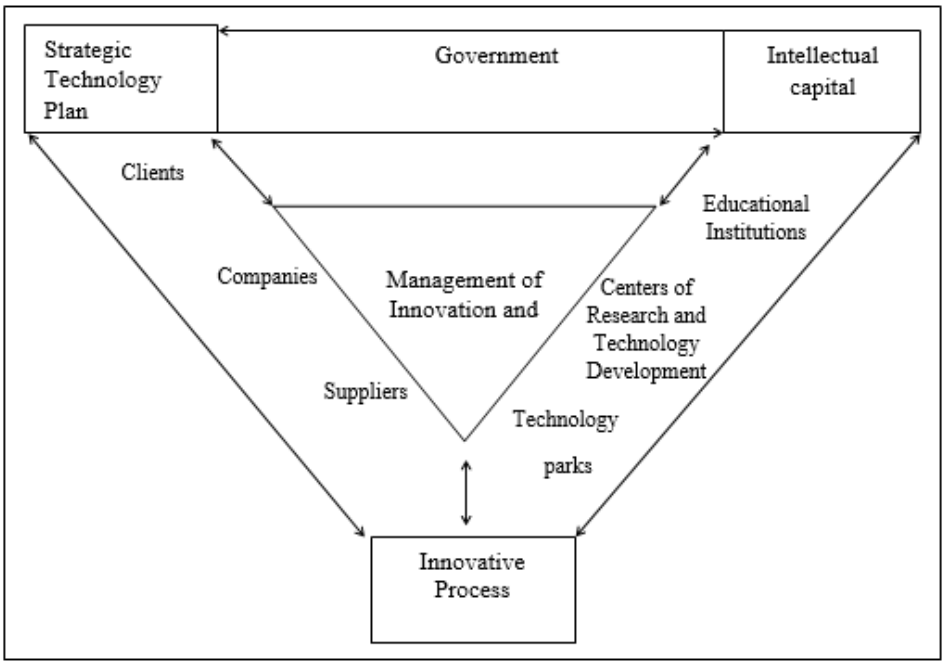


***Figure 1. Management of Innovation and Technology in the certified software companies in Sinaloa***

Using the Mixed Methods approach, the quantitative tool is based on the information from a survey that was administered personally to the managers of nine software companies from Sinaloa which are certified by the CMMI in 2013; these companies are located in the three major cities of the state: Culiacan, Mazatlan and Los Mochis, and were selected considering their importance in the market, the efficiency and stability of their projects and because they generate innovation in the local market. According to the number of employees, the sizes of the companies are as follow: 56% are small, 22% are medium and the rest 22% are micro companies.

As part of the qualitative analysis, we interviewed nine software developers, one from each company. Both tools evaluated 39 items and were designed based on the three main dimensions described in the model: strategic technology plan, innovative process and intellectual capital. Each dimension is explained by thirteen activities (indicators) that were assessed using a five level Likert scale that goes from the statement of *strongly*

*disagree (1)* to *strongly agree (5).* Considering Devellis (1991), the internal consistency among the items of the questionnaire were determined by Cronbach's alpha coefficient, with a value of 0.83 that ensure its validity.

In order to determine which activities are the most and/or least practiced by the companies, we will use the mean and standard deviation as parameters of centralization.

## Results and discussion

In this section we describe the results of the statistical analysis regarding the performance of the management of technology and innovation within the companies under study. The results are presented considering the three dimensions of our model described above.

### *Strategic technology plan*

*Planning innovation projects*
Entrepreneurs recognize the importance of planning innovative projects; 66.7% of the survey respondents s*trongly agree* that their companies work on innovation projects plans. The mean score of this indicator was 4.67, representing the highest score within this dimension of analysis.

*Identification of business opportunities in new markets*
Entrepreneurs agree that business opportunities may guarantee their entry and stay in foreign markets; from the survey we found that 66.7% of the respondents *strongly agree* and 33.3% *agree* with this statement; alike the previous indicator, its mean score was 4.67.

*Monitoring and controlling innovation projects*
The score mean of this activity was 4.56, which makes it the second most important indicator. According to the survey respondents, 66.7% of the companies *strongly agree* in monitoring and controlling their innovation projects, 22.3% *agree* in their implementation, while 11.1% *neither agree nor disagree,* and said they do not implement this type of activity. The diversity in the answers is reflected in the standard deviation of 0.68. COTEC (2010) defines planning innovation as a permanent open process to identify the dynamic reorientation of the strategy and to address the opportunities and difficulties that affect the schedule of other projects that may be prioritized or delayed, even canceled if needed.

*Identification and continuous adoption of the best innovative industry practices*
This is the third most important activity with a score mean of 4.4. Entrepreneurs recognize it as part of their strategies; 55.6% of the respondents *agree* with this statement. The rest 44.4% *strongly agree* that identifying and adopting the best innovative practices in the industry is crucial for staying in the market. According to Blazquez (2009), learning the best practices from similar organizations in a context of constant change is an excellent opportunity for continuous improvement and progress; a greater capability to receive information about the current changes shall bring greater advantages.

*MIT is relevant in the design of the strategy*
This activity is in fourth place with a score mean of 4.33 and a standard deviation of 1.05 which explain the variability of the answers; 66.7% of the respondents *strongly agree* that their company uses the MIT as part of their competitive strategy, 11.1% *agree* in considering the MIT in the design of their strategy, and 11.1% *neither agree nor disagree* and do not consider it as an important activity. For Blazquez (2009), innovation should be focused on business strategy and managed with the traditional techniques of strategic planning.

The following four activities are tied in fifth place sharing a score mean of 4.22.

*An understandably innovation strategy*
According to the survey, 44.4% of the companies *strongly agree* and have a clear innovation strategy; 33.3% *agree*, although their strategies are not very clear or precise; 22.2% *neither agree nor disagree*. An innovation strategy as the guideline that determines where and how to innovate must be dynamic, flexible and sustainable; since changes may occur within or outside the company, the strategy should be reoriented to take advantage of the opportunities or to face new threats (COTEC, 2010).

*Evaluation of the innovation projects results*
Opinions indicate that 44.4% of the companies *strongly agree*, 33.3% *agree* and 22.2% *neither agree nor disagree* with this statement. According to the manager of a cluster, evaluating innovation projects "should be a best practice to implement."

*The projects portfolio includes the acquisition of external technology*
33.3% of the respondents *strongly agree* and 55.6% *agree* in the importance of this activity, while 11.1% *neither agree nor disagree* with this statement.

These results are consistent with the postulates of Lee and Omm (1994) who state that planning the acquisition of technology is mainly decided considering economic aspects, especially when technology is changing so rapidly. The relationship and dependence on external organizations increase as well as the need to mobilize the external financial and technical capabilities to face the strong competition and the product's short life cycles.

*Own technological infrastructure for the development of innovative projects*
An important condition to innovate is to have an adequate infrastructure for conducting R&D projects. While companies experienced financial difficulties, 22.2% of the employers *strongly agree* in having technological infrastructure and 77.8% *agree* to have developed their innovative projects with technological infrastructure. Entrepreneurs recognize the importance of infrastructure, since 90% of the respondents said they have improved their facilities and technological equipment in the past two years. The importance of having an appropriate IT infrastructure was pointed out by the Economic System of Latin America and the Caribbean (SELA, 2009), considering it an essential part of the conditions to hire local offshore companies.

*Constant evaluation of production processes*
This activity is in sixth position with a score mean of 4.11, considering that 44.4% of the respondents *strongly agree* and 22.2% *agree* with this statement and said they have implemented this evaluation. However, 33.3% of the respondents said they *neither agree nor disagree* with this statement, arguing that if a process is functional does not need to be modified. Chen, Hoi and Xiao (2011) recognize that the permanent evaluation of the development processes is an essential task to correct problems, in order to reduce development costs, increase productivity and improve the quality of products, particularly in innovative businesses.

*Constant evaluation of marketing methods*
This indicator is placed in the seventh position with a score mean of 4.00. From the survey, 33.3% of the respondents *strongly agree and* 33.3% *agree* with this statement; the rest 33.3% *neither agree nor disagree* and do not perform any permanent evaluation of their marketing methods. It was found that there is a lack of attention in this area, in fact the micro and small enterprises do not have any department or employee specialized in this activity, instead the employer is in charge of this process himself. This finding is not new to Horwitch and Prahalad (1976) who stated that it is common for a manager to have the responsibility of various tasks such as manufacturing, marketing, and engineering. Moreover a common failure in

the micro and small companies is the lack of attention to marketing issues.

*The implementation of a precise MIT system*
It is the eighth most important activity with a score mean of 3.89. Opinions regarding this indicator vary: 22.2% of the respondents said they *strongly agree* with this practice; 55.6% *agree* and 22.2% *neither agree nor disagree*. The respondents said they personally know the concepts of innovation management but they are not known in their company. It was also possible to observe that the companies apply the concepts of innovation management but they are not formally considered in their strategy. The importance of managing innovation systems has been marked by Tuominen, Piippo, Ichimura and Matsumoto (1999) who suggest that a company should have a system of innovation management that works adequately and guides the innovation process correctly, therefore the result shall be a successful new product or service.

*Market research to determine the technological efforts of the company against current and future competitors*
Among the elements of technology planning and strategy, this one is placed in the last position with a score mean of 3.78. From the survey we found that 33.3% *strongly agree* and 22.2% *agree* in developing marketing research, while 33.3% *neither agree nor disagree* and 11.1% *disagree*. This practice encourages the companies to stay alert and explore the external environment in order to identify opportunities for the development and launch of new goods, services and processes applying new technology, studying the customers needs, observing the suppliers strategies and even some competitors or companies from other sectors (COTEC, 2010).

***Innovative process***

*Constant contact with customers*
This indicator is in first place with a score mean of 4.56. From the survey we found that 55.6% of the respondents *strongly agree* and 44.4% *agree* with this statement. Managers consider it a very important practice that allows them to meet the market needs of new products and services. These findings concur with the views of De Jong and Kemp (2003) who state that contact with customers is one of the most influential aspects in the innovative behavior of the employees.

*Databases of procedures and lessons learned*
This indicator is ranked in second place with a score mean of 4.11 and a standard deviation of 0.99, which reflect the variability of the given answers. On the one hand 44.4% of the respondents *strongly agree* with this

statement and 33.3% *agree*. With these results, it is possible to notice that the entrepreneurs have a concern for anticipating future actions and learning from the successes and failures of their organizations. On the other hand, 11.1% *neither agree nor disagree* and the rest 11.1% *disagree*. The overall results are consistent with the postulates of Lilly and Porter (2003) who recommend the use of databases as a technique to store acquired knowledge and experiences that would facilitate learning and reduce the recurrence of errors in the process of developing new products.

*Considering the suppliers as a source of knowledge*
This indicator is in third position with a score mean of 4.00. Entrepreneurs recognize the importance of suppliers as an external source of knowledge. The results of the survey are that 22.2% of the respondents *strongly agree* and 55.6% *agree*. While only 22.2% *neither agree nor disagree* with this statement. According to Teece, Pisano and Shuen (1997) customers and suppliers are an important source of external knowledge, and it is possible to build a virtuous cycle of constant innovation and improvement from their interrelationships.

*Research and development policy*
This indicator is in fourth place with a score mean of 3.89. According to this parameter and the opinions of the interviewed leaders, 22.2% of the companies *strongly agree* and have a formal internal R&D policy. By contrast, 44.4% just *agree* and reported having an informal policy while 33.3% *neither agree nor disagree* and reported not having any policy established; therefore they define their R&D strategies according to their current needs. These results contradict Lee and Omm (1994) who consider the R&D policy as an essential tool to make decisions in the selection, acquisition or development of technology. It allows internalizing acquired technologies considering the internal R&D capabilities and the relationship with other institutions.

*Collaboration with other companies*
Like the previous indicator, this one is ranked in the fourth position with a score mean of 3.89 and a standard deviation of 1.66, which explains the variability of the opinions: 66.7% of the companies *strongly agree* and said they collaborate with other companies, although 22.2% *strongly disagree* and expressed not having any contact with other software development companies. In this sense, it is important to mention Powell, Koput and Smith-Doerr (1996, p.117) findings: "When there is a system of rapid technological development, research advances are so widely distributed that no single company has all the necessary internal capacity for success"; consequently, companies carry out their production process, from the

discovery to the distribution through some form of external collaboration.

*Allocation of sales percentage in R&D*
This activity is in fifth place with a score mean of 3.44 and a standard deviation of 1.34 since the opinions varied. That is, 33.3% *strongly agree*, 11.1% *agree*, 33% *neither agree nor disagree*, 11.1% *disagree* and the rest 11.1% *strongly disagree*. In general, companies said to invest between 30% and 40% of their sales and 11.1% invest between 5% and 10% of their total revenue. As a whole, software companies invest 25% of their sales in R&D, which is a high percentage considering that they are using their own resources. Audretsch (1998) suggests that the investment that universities do in R+D may represent an important source of innovations for the small enterprises. This means that part of the investment made by software companies in Sinaloa should be in collaboration with educational institutions in the region.

*Collaboration with educational institutions*
As with the previous activity, this one is in fifth place with a score mean of 3.44 and a standard deviation of 1.57. When entrepreneurs were asked if they collaborate with educational institutions, 33.3% of them *strongly agree* and other 33.3% just *agree*, and said they have some kind of collaboration with a university or community college. While 33.3% of the respondents *neither agree nor disagree* and said not to have any kind of agreement with these organizations. However, when they were questioned about the types of collaboration or agreements they currently have, they said that the business-university collaborations are instituted only for the purpose of supplying social service providers as part of the students' professional practices. In general, both employers and academic leaders of the software industry in Sinaloa recognize the absence of a real partnership between companies and educational institutions. The lack of collaboration, together with the absence of foreign investment could explain the fact that the companies have to invest 25% of their total sales in R&D; According to Pavitt (2003) research in the universities should be related to the innovation activities of the enterprises, and then new knowledge, techniques and skills can be provided by the universities.

*Registration and protection of intellectual knowledge and innovations*
This indicator is placed in sixth position with a score mean of 3.3, which represents that 44.4% of the respondents *strongly agree*, 11.1% *agree* and 11.1% *neither agree nor disagree* with this business statement. By contrast, 33.3% said they *strongly disagree* with protecting and registering the knowledge and innovations developed by their companies. These opinions contrast the information related to the property titles registered by these

companies, since out of a total of 50 property titles registered by all of them, 74% belong to three companies and the remaining 26% are distributed among six companies. Entrepreneurs mentioned they have identified the knowledge and innovations that require protection and intellectual registration but do not have a budget to pay for such registrations. Cockburn and MackGarvie (2006) explain that some companies have simply stopped considering the strategic value of patents in the industry and for many entrepreneurs the costs of obtaining patents outweigh the benefits; especially in such dynamic sector as it is the ICT.

*Collaboration with governmental entities*
44.4% of the respondents *strongly agree* with having a partnership with government entities, however, another 44.4% *strongly disagree* with this practice. The score mean of this indicator is 2.67 and its standard deviation is 1.33 due to the variability in the given answers. According to Porter and Stern (2001), a solid common innovation infrastructure requires national investments and long-term governmental policies.

*Collaboration with technology parks*
This indicator is in eighth position, with a score mean of 2.44 and a standard deviation of 1.57. According to the survey, when the entrepreneurs were asked if they collaborate with technology parks, 22.2% *strongly agree*, 22% *neither agree nor disagree*, and 44.4% s*trongly disagree*, which means that most companies do not collaborate with technology parks. However, the collaboration alluded by the respondents is related to the fact that their companies are located in the so called "Sinaloa Entrepreneurship and Innovation Park", but they do not have developed any innovative projects within this park.

*CMMI Certification*
The score mean of this activity is 2.33, which means that even though the CMMI model has evaluated all the companies, only 33.3% are qualified for Maturity Level 2 and the rest, represented by 66.7% of the companies are qualified for Maturity Level 3. It is important to mention that these companies also have the MoProSoft certification, although entrepreneurs see this certification as a weakness, because it does not have international recognition. These observations are consistent with the assumptions of Corona and Paunero (2011) who say that software companies in Mexico do not have the resources to invest in certifications. It is important to note that the cost of implementing the CMMI quality model in these firms has been largely subsidized through federal and state programs for the promotion and development of the software industry, specifically through ProSoft (Program for the Development of Software Industry and Innovation).

*Collaboration with research and technological development centers*
Positioned in tenth place, this indicator has a score mean of 1.33, value that is significantly below the overall arithmetic means of the innovative process indicators. In this regard, 11.1% of the respondents *agree* with this statement and refer collaboration with the Center for Electronic Design located at the ITESM Campus in Guadalajara, while 88.9% *strongly disagree* and report not to have any collaboration with development centers.

SELA (2009) observes that Latin American countries do not show important evidence of agreements or formation of alliances between companies and other public and private organizations, such as competitors, universities and research centers, which makes it difficult for the companies to move towards upper stages in order to strengthen technological developments and innovation.

*Research and development activities*
These activities have a score mean of 1.22, well below the average arithmetic mean of 2.5, positioning this indicator in last place. According to the survey, 88.9% of the respondents *agree* to perform R&D activities with specific staff, but do not have an exclusive department or center to carry out these tasks, while 11.1% *strongly agree* and have an exclusive department for these matters. It seems contradictory that even when software companies mentioned that 25% of their sales are invested in R&D activities, most of the companies do not have an exclusive department to develop such activities. According to SELA (2009), the success of software firms in Israel is largely due to their important research work and development oriented innovation, which is not limited to simple engineering tasks.

### *Intellectual capital*

*Open communication between employees and executive managers*
This activity ranks in first place with a score mean of 4.67 since 77.8% of the respondents *strongly agree*, 11.1% *agree* and the rest 11.1% *neither agree nor disagree* with this statement. Employers acknowledge the importance of being in constant communication with their employees since that allows hearing ideas that may lead to improvements. The need for interdepartmental communication is critical to any organization. Such communication put together the efforts to create a specific development plan and publicize innovative ideas. It helps them understand ideas for change and anticipate future actions. These ideas are supported by Hidalgo, Vizan and Torres (2008).

*Teamwork is a common practice in the company*
As with the previous indicator, this one also has a score mean of 4.67. We found 66.7% of the respondents *strongly agree* and 33.3% *agree* with this statement. We were able to observe teamwork in practice when we visited them. In concordance with Hidalgo et al. (2008), teamwork is particularly relevant for the operation of an innovative company and it is a key element for innovation management and the design of technological systems.

*Promote work environment that foster the generation of knowledge and innovative ideas*
This indicator also has a score mean of 4.67. From the survey, 66.7% of the entrepreneurs *strongly agree* and 33.3% *agree* with this statement, which implies that all the companies are committed in promoting an appropriate work environment for the generation of knowledge and ideas that can become innovative products and services. Human capital contributes to the promotion of the innovation process by developing creativity and curiosity about the unknown. It also helps to consolidate the aspects of quality and productivity, as well as the ability to produce cheaper and faster than competitors; these are essential skills for generating innovative products and services (Hidalgo et al., 2008). For that, it is necessary to have an appropriate work environment that promotes positive attitudes towards employees' participation (Urbano, Toledano & Ribeiro-Soriano, 2011).

*Employees are committed to the company*
This indicator is in second position with a score mean of 4.56 since 55.6% of the respondents *strongly agree* and 44.4% *agree* with this statement. This indicator is closely linked to the three previous statements. It is through open communication between employees and management, teamwork and a working environment that promotes the generation of knowledge and innovative ideas that it is possible to have employees who are committed to their work. According to Pedraja, Rodriguez and Rodriguez (2006), the innovation process requires the commitment of the employees. The manager's challenge is to create an environment that allows the creation of effective strategies along with the confidence, commitment and cooperation of the employees, who are the key to implementing the company's innovative strategy.

*Generating innovation considering employees skills*
Similar to the previous indicator, this item was placed in the second position with a score mean of 4.56. We found that 55.6% of the respondents *strongly agree* and 44.4% *agree*with this statement. One of the managers interviewed stated that not only should the employees' knowledge be considered in generating innovation but they also must participate in the

design of the innovation strategy. Coinciding with Hidalgo et al. (2008), the employees' ideas are the catalyst for the innovation process and become essential for the company. Therefore, to ensure the proper management of creativity it is necessary to analyze all the possible emerging ideas, be willing to question other opinions and accept the judgments of others.

*Promoting job stability*
This indicator also has a score mean of 4.56. Similar to the previous results, 55.6% of the respondents *strongly agree* and 44.4% *agree* in promoting their workers stability. Entrepreneurs agree that this practice has benefited the staff permanence in the company. These opinions are supported by Hidalgo et al. (2008) who state that the internal factors that drive technological innovation are the result of the company actions and depend on the management leadership, motivation and commitment to developing the human capital of the company.

*Ongoing employee training*
This is the third most important indicator, with a score mean of 4.33; On one hand, 77.8% of the interviewed companies *strongly agree* and said they provide ongoing training to their employees and 11.1% *neither agree nor disagree* to this statement; On the other hand, 11.1% s*trongly disagree* and said they have not trained their personnel and other 11.1% said they have only trained 55% of their staff. Because of the diversity of these results, the standard deviation was 1.33. In general, the opinions allude to the idea that ongoing training starts when their employees are hired, mainly for the technological area; although 33.3% of them reported a lack of training in the area of marketing.

*Employees committed with the innovation strategy*
This indicator is in fourth place with a score mean of 4.1, since 33.3% of the respondents *strongly agree*, 44.4% *agree* and 22.2% *neither agree nor disagree*. We observed that entrepreneurs recognize the importance of considering their employees ideas and opinions as part of a strategy for success which coincides with Pedraja et al. (2006) who state that by sharing knowledge in a participatory manner, it is possible to achieve trust and cooperation in the implementation of an innovative strategy. In that sense, one of the challenges of management is to ensure that employees are aware of, and involved in the design of the strategy and feel committed to it.

*Proper management of human resources*
This indicator is in fifth position with a score mean of 4.0. From the survey, we found out that 22.2% of the respondents *strongly agree* and 66.7% only *agree* that they have a proper Human Resources management in their

company, but 11.1% of the respondents *disagree* with this statement. They say they do not have the structure and personnel to carry out effective initiatives in this area. The data allows us to infer that it is mainly the medium sized companies that have an exclusive Human Resources department, but in the small and micro companies, it is the responsibility of the administration, the manager or some other person with other duties. Therefore, it is important to emphasize that although this practice is well acknowledged by these companies the findings of Mayson and Barrett (2006) suggest that there is evidence that in small companies, the management of employees is characterized as informal.

*Technological skills of the employees*
According to the survey this activity is in sixth place since 22.2% of the respondents *strongly agree*, 44.4% *agree*, another 22.2% *neither agree nor disagree* and 11.1% *disagree* when considering this statement. The indicator has a score mean of 3.78 and its standard deviation was 0.92 due to the diversity of the given answers. For Lopez and Millan (2013), an important factor in the innovation process is human resources with skills and knowledge but also with aptitude to participate and promote the innovation processes. Particularly in the software sector, the availability of skilled and creative workers has been a great challenge, both for the lack of resources and the lack of adequate technological skills (Lippoldt & Stryszouwski, 2009).

*English proficient employees*
This indicator is in seventh place, with a score mean of 2.89 and a standard deviation of 1.10. On one hand, 11.1% of the companies *strongly agree* and other 11.1% just *agree* that their employees are fluent in English. On the other hand, 22.2% *disagree* and 11.1% *strongly disagree* with this statement. Hualde, Jaen and Mochi (2010) assert that Mexico lacks the competitive advantage of having fluent English speakers in comparison with other countries like India and Ireland.

*Employees' education level*
This indicator represents the academic level of the intellectual capital that generates innovations in the software companies. Considering the levels of education (technical, bachelor, master and doctorate), this indicator has a score mean of 2.33, reaching a penultimate place in this rank. From a total of 275 workers, we found that 1.45% have a technical degree, 94.9% have a bachelor degree and 3.64% hold a master's degree. According to Nelson and Phelps (1996) having skilled human capital allows the creation of new and better production techniques and thus an economy with great potential to improve productivity and growth.

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*Employees' certification*
This indicator is the last one in the list with a score mean of 1.11 and a standard deviation of 0.31. Only two of the participating companies have had their IT employees certified in the past two years, which represents 22.2% of the respondents who *agree* with this statement. The rest of the companies *strongly disagree* and do not certify their employees because of the high cost and the small benefit it brings. Employers believe that certifications are only a reference of the minimum knowledge their employees must have regarding their technological competence when they are being hired, but they do not guarantee better performance than those who do not have such certifications. These opinions contradict Naveda and Sheidman (2005) who claim that a professional certification signifies mastery of knowledge, commitment to the profession and responsibility with an outgoing training process. Certification enhances the ability of the organization to provide quality software products, on time and within the budget. It also establishes minimum levels of education and professional experience in software engineering and demonstrates the commitment of the organization to the professionalism of software engineering.

## Conclusions

When looking for an answer to the main question of this research: How do the software companies from Sinaloa manage technology considering their strategic technology plan, innovative process and intellectual capital? Our findings show evidence that these companies manage innovation informally, through an internal, expensive and independent innovation process, without considering strategic alliances.

The efforts that have been mainly made by the entrepreneurs, even with limited participation of the educational institutions, government, technology parks or research centers are observable; although the companies still need more long-term strategic projects, invest in R&D, train and certify their employees in technological competences and English, create joint ventures, access to new markets and even register their shared knowledge and innovations. Consequently, even the entrepreneurs have acknowledged the importance of R&D policies and have invested a high percentage of their income in R&D, we still can observe that this has been done in a very basic way. Therefore, the results are products or services with minimal innovations with no relevant impact on the international market.

Finally, it is important to mention that even though software companies

have made efforts to register their knowledge through patents and copyrights, these companies have failed in acknowledging the strategic value of these elements in their industry.

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