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ENHANCING SECURITY IN MANET USING TRUST MANAGEMENT SECURITY SCHEME WITH UNCERTAIN REASONING

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THEORETICAL APPROACHES FOR THE ANALYSIS OF INNOVATION CAPACITY AS A FACTOR THAT AFFECTS THE COMPETITIVENESS OF SOFTWARE INDUSTRY OF JALISCO

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ABSTRACT

A mobile ad hoc network (MANET) is formed with wireless mobile devices (nodes) without the need for existing network infrastructure. Security design in MANET (Mobile advoc network) is complicated because of its features including lack of infrastructure, mobility of nodes; dynamic topology and open wireless medium. Due to this MANET suffer from many security vulnerability. To enhance the security, it is very important to rate the other node which is trustworthy. Hence a unified trust management security scheme is used. In trust management security scheme, the trust model has two components: direct observation and indirect observation. In direct observation, trust value is calculated from an observer node to observed node using Bayesian inference type of uncertain reasoning. On the other hand, indirect observation is also referred as secondhand information which is obtained from neighbor nodes of the observer node; the trust value is calculated between them using Dempster-Shafer theory, which is another type of uncertain reasoning. By combining these two components in the trust model, a more accurate trust value is obtained. This will help to improve throughput and packet delivery ratio in the network.

Index Terms - *MANETs, Security, Trust Management, uncertain reasoning.*

I. INTRODUCTION

A MANET Stands for "Mobile Ad Hoc Network." is a type of ad hoc network that can dynamically change locations and self configuring on the fly. Because MANET consist of mobile nodes, they use wireless connections to connect directly or relying on other mobile node as router to various networks. This can be a standard Wi-Fi connection, or another medium, such as a cellular or satellite transmission [1]. In cases, where no network infrastructure exists, such as in war zones, relief efforts in remote territories, and emergency

situations a mobile ad hoc network is used. Such network does not depend on preexisting/centralized infrastructure and base stations. In decentralized network all network activity including discovering the topology and delivering messages to the other nodes must be executed by the nodes themselves [2]. The applications for MANETs are diverse, ranging from small, static networks to large-scale mobile highly dynamic networks [1]. Other than application, MANETs need efficient distributed algorithms to determine network organization, link scheduling and routing [2] [7]. The network protocol which is design for these networks is such a complex issue [2].

Open and closed are the two types of MANETs [1]. In open MANET, different nodes having different goals and they share their resources with each other for connecting globally. In closed MANET, all mobile nodes which are in networks cooperate with each other to achieve a common goal. MANET suffers from many security attacks Because of its distinct features including lack of infrastructure, node mobility, dynamic topology and open wireless medium [5]. Therefore security is challenging issue in MANET [1]: Cryptography and key management schemes seem good [5], but they are too expensive in MANET. Prevention-based and detection based are the two approaches that are used in MANET [6]. In prevention-based approaches a centralized key management is required, which may not be possible in MANET because of its distributed networks. The whole network may be affected if the infrastructure is destroyed. So this approach is used to prevent misbehavior but not detect malicious nodes. Detection based approaches are used to detect selfish node that helps to identify malicious misbehavior. Detection based approaches are based on trust in MANETs [3]. Hence this approach is used to calculate trust value in trust management schemes.

Most of the detection based approaches based on trust in MANETs, may not use both direct and indirect observation (second hand information obtained from neighbor node or third party node). Trust evaluated from direct observation not able to differentiate data and control packets. For security in MANETs, it is important to identify nodes that are trustworthy to other nodes without using centralized authorities for building up a trust environment. Such mechanisms not only help to detect malicious node, but also improve network performance. For evaluating trust value we are using both direct & indirect observation. In this paper, trust value calculation means degree of belief that is node performs as expected and also we identify uncertainty when trust value is to be evaluated. In existing scheme, while evaluating trusts value uncertainty factor is not considered, but here we consider uncertainty while trust value is calculated. Hence, unified trust management security scheme is used to enhance security of MANET with uncertain reasoning.

II. LITERATURE REVIEW

- In paper "Security Enhancements for Mobile Ad Hoc Networks with Trust Management Using Uncertain Reasoning" [1] Zhexiong Wei, Helen Tang, F. Richard Yu, Maoyu Wang & Peter Mason, IEEE transaction paper2014 has discussed that because of Dynamic topology & open wireless medium MANETs suffering from many security vulnerabilities. Hence a Unified trust management scheme is used to enhance the security in MANETs. In this scheme, the trust model has divided into components: Trust value is calculated from direct and indirect observation.
- In paper "A Survey of Secure Mobile Ad Hoc Routing Protocols"[2] Loay Abusalah, Ashfaq Khokhar, and Mohsen Guizani, IEEE transaction paper 1999 has discussed that Several routing protocols have been used in Mobile Ad hoc Networks (MANETs) such as military, government & commercial applications. These protocols focus on security issues and differentiate in terms of routing methodologies. Four routing protocols are most widely used for analysis and evaluation including: AODV, DSR, OLSR and TORA.
- In paper "Joint topology control and authentication design in MANET with cooperative communication, [3] Q. Guan, F.R. Yu, S. Jiang IEEE Transaction paper 2012 has discussed that Mobile ad hoc networks (MANETs) based on cooperative communication (CC) suffering from many challenges regarding security, network performance & management issues. Joint authentication & topology control (JATC) scheme is used that combine both Authentication & topology control to improve the throughput.
- In paper "An Acknowledgment-Based Approach for the Detection of Routing Misbehavior in MANETs" [4] Kejun Liu, Jing Deng, pramod K. Varshney, Kashyap Balakrishnan, IEEE transaction paper 2011 has discussed that routing misbehavior can be avoid using acknowledgement scheme. 2ACK scheme is used to detect misbehavior in routing and mitigate their effect.
- In paper "Securing Mobile Ad Hoc Networks with Certificate less Public Keys"[5] Yanchao Zhang, Wei Liu, Wenjing Lou and Yuguang Fang, IEEE Transaction 2006 has discussed that a fundamental problem in securing MANETs. IKM is an ID-based key management scheme which is a combination of ID-based & threshold cryptography. IKM is a certificate-less solution that eliminates need for certificate-based authenticated public-key distribution
- In paper "Structural Results for Combined Continuous User Authentication and Intrusion Detection in High Security Mobile Ad-Hoc Networks" [7] Shengrong Bu, F. Richard Yu, Xiaoping P. Liu, and Helen Tang, IEEE Transaction 2011 has discussed that how effectively malicious activities can be identified. Intrusion detection systems (IDSs) and user authentication these two approaches jointly consider for effective security design.

III. PROPOSED METHODOLOGY

The main goal of MANET is to establish trusted connection amongst each other. In detection based approaches, Unified trust management security scheme is one of the important methods [1]. By using trust information, node does not take highly risky action such as forwarding or sending the data packet to the node which is having low trust value. In trust management security scheme, trust model has two components: trust value which is calculated from direct observation & indirect observation. In direct observation, trust value is calculated from an observer node to observed node. Indirect observation is also referred as secondhand information which is obtained from neighbor nodes of the observer node. Indirect observation or second-hand information is used to evaluate trust value of observed nodes from neighbor node. Indirect information is very important as Compared to direct observation. Example: information collected from neighbor nodes can able to detect situation where particular node's behavioral is well or not.

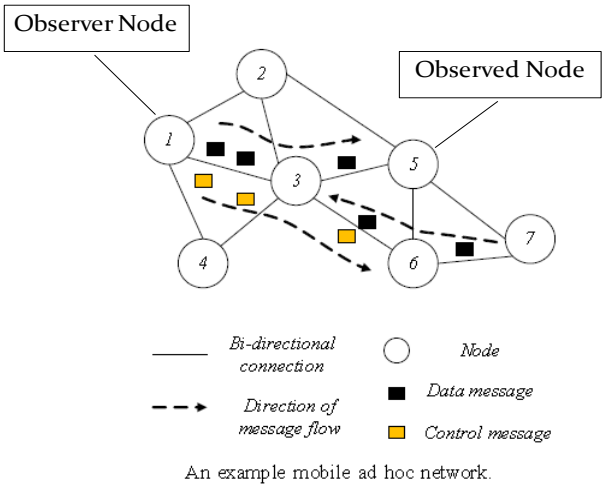

Fig 1.An example Mobile Ad hoc network

In this example, two types of messages send between nodes data and control messages. Node 1 is act as an observer node and node 3 is an observed node. In this case Node 1 sends data messages through node 3 to node 5. When node 3 forwards messages to node 5 then node 1 can observe the communication this is direct observation. Based on this observation node 1 can calculate the trust value of node 3. The same idea is applied to the control message situation. Meanwhile, node 1 can collect information from node 2 and node 4 to evaluate the trust value of node 3. Here node 2 and node 4 are neighbor nodes of node 1 and information collected from third party nodes is called indirect observation.

In direct observation, trust value is obtained using Bayesian methodology. Here trust act as uncertainty that

the observed node performs a task correctly and entropy is used to evaluate trust value by direct observation. Indirect observation also very important for example, evidence collected from neighbor nodes is detecting the situation where a node performs friendly with someone and unfriendly with other nodes. Dempster-Shafer theory (DST) methodology is used for indirect observation in uncertain reasoning which is widely used in expert system.

Uncertainty refers to the degree to which an individual or organization cannot accurately predict the behavior or the environment. Uncertainty originates from information asymmetry and opportunism. Due to uncertainty it increases the transaction cost and decreases the acceptance and cooperation between nodes. To efficiently reduce uncertainty and speed up trust convergence uncertain reasoning is used. Uncertain reasoning theory is use from Artificial intelligence to evaluate the trust value of node in MANET [9]. By using trust value we can easily separate newcomers from misbehavior and make certainty based decision possible. Trust enables entities to cope with uncertainty and uncontrollability caused by free will of others. Traditional rule base system is based on truth table with no option. This drawback is overcome using probabilistic reasoning, in which the uncertainty knowledge is considered. Bayesian methodology and Dempster-Shafer theory (DST) are two approaches in uncertain reasoning. We accept them to calculate trust value from direct and indirect observation.

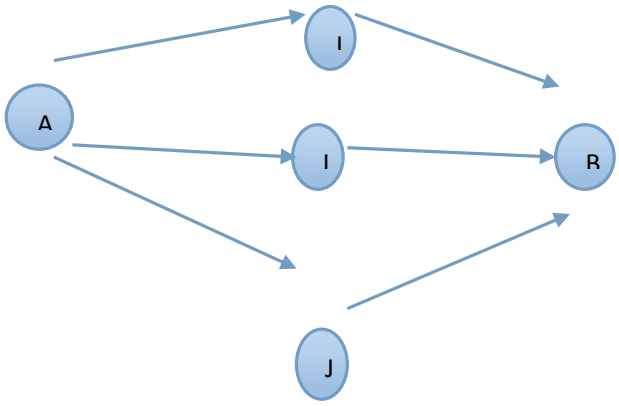

Fig. 2. A scenario for indirect observation.

Algorithm 1 Trust Calculation with Direct Observation

1: **if** node A, which is an observer, finds that its one-hop neighbor, Node B that is a trustee, receives a packet **then**

2: the number of packets received increases one

3: **if** node A finds that node B forwards the packet successfully

then

4: the number of packets forwarded increases one

5: **else**

6: **if** TTL of the packet becomes zero **or** overflow of

buffers in node B **or** the state of wireless connection

of node B is bad **then**

7: the number of packets received decreases one

8: **end if**

9: **end if**

10: **end if**

11: calculate the trust value, TS, from (8) and update the old

one.

Algorithm 2 Trust Calculation with Indirect Observation

if node A, which is an observer, has more than one one hop

neighbors between it and the trustee, node B **then**

2: calculates the trust value, TN, from (18)

else

4: set TN to 0

5:set λ to 1

6: **end if**

IV. TECHNIQUES USED TO IDENTIFY SELFISH NODES

Selfish or misbehaving nodes which are present in MANET can disrupt the working of network and degrade the performance of the network. Hence, it is very important to detect and remove these selfish nodes. Following are the various techniques available to prevent the selfishness in MANETs [4]:

A. *Cooperative communications:-*

Using cooperating mediator nodes in the network, Mobile devices in ad hoc networks communicate with each other through a multi-hop route. Cooperative communication between nodes has been important to improve transmission reliability, performance and security of the network. If centralize coordination is not present between nodes, then many security issues may arrives. For example if selfish node present in network, then nodes does not cooperate with each other and start dropping packets. In MANET battery power is considered to be more important hence to reduce battery power consumption, nodes refuse to share its own resources and such nodes are selfish node. Selfish node may participate in the route discovery and maintenance process but they rejected to forward data packets. So because of these malicious node packet delivery ratios deteriorate or break significantly.

B. *Credit based system:-*

In credit-based schemes, the basic idea is to provide incentives for the nodes that sincerely perform their task. Virtual (electronic) currency or similar payment system may be used to perform networking functions such as forwarding and receiving packets. Payment is given to the nodes for providing services to other nodes. When they request other nodes to help them for packet forwarding, they use the same payment system to pay for such services [4]. Several schemes are used credit based system for packet forwarding: Packet Purse Model and the Packet Trade Model. Another scheme is Sprite, in which nodes keep receipts of the received/forwarded messages. The main problem with credit-based schemes is that tamper-resistant hardware and/or extra protection for the virtual currency is required in this scheme.

C. Reputation-based scheme:-

Reputation or trust based models are one of the approaches that enforce cooperation between nodes and mitigate node misbehavior. Reputation is a factor which is calculated through direct interactions through monitoring or observing the nodes and/or indirect information collected from neighbors. A node can trust its direct information more than the indirect information. Reputation based schemes are classified based on their monitoring component: as using either active or passive acknowledgments.

Example of Reputation-based scheme:-

Watchdog: Watchdog technique is used to detect routing misbehavior and mitigate its effect in MANETs. In watchdog technique, it observer the medium to check whether the next hop node is trustworthy and maintains the buffer to store recently sent packets. If a data packet present in the buffer for long time, the watchdog module accuses next-hop neighbor misbehavior.

Pathrater: Based on the watchdog's allegation, the pathrater module give rating to every path in its cache and subsequently chooses the best paths that avoid nodes misbehavior. This technique is more reliable than watchdog technique.

Confidant: Cooperation of Nodes-Fairness in Dynamic Ad-hoc Networks (CONFIDANT) is a security model for MANETs based on selective altruism and utilitarianism [6]. In this scheme, for computation of reputation values both first-hand and second-hand information is used. It is a distributed, symmetric reputation model most commonly used.

V. CONCLUSION:

A unified trust management security scheme is used to enhance the security of MANETs. Using recent advances in 'Uncertain Reasoning', Bayesian inference and Dempster-shafer theory,system evaluates the trust values of observed nodes in MANETs. In MANET Misbehavior such as 'Dropping' or 'Modifying packets', can be detected through trust values which is obtained by direct and indirect observation and Nodes with low trust values will be excluded or remove by the routing algorithm. In this way secure routing path can be established in malicious environments which help to improves throughput and packet delivery ratio.

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THEORETICAL APPROACHES FOR THE ANALYSIS OF INNOVATION CAPACITY AS A FACTOR THAT AFFECTS THE COMPETITIVENESS OF SOFTWARE INDUSTRY OF JALISCO

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ABSTRACT

The aim of this work is to review the theoretical approached to analyze the innovation capacity of enterprises in the software industry of Jalisco, based on a survey of the companies in the Software Center of the State, as well as evaluating the influence that has the capacity for innovation on competitiveness, seeking empirical evidence to answer the question. The main hypothesis for this research is the ability to innovate is a factor that positively affects the performance of companies in the software industry, which is reflected in the competitiveness of sector. The methods used in this research are three: innovativeness index (ICI), Linear Regression Model with OLS and Soft Computing using evolutionary algorithms: FUZZY CESAR, the latter something very new which puts us in the forefront of knowledge in methods it is still.

Keywords: Competitiveness, software industry, innovation

Resumen in Nativa Language:
El objetivo de este trabajo es revisar los acercamientos teóricos para analizar la capacidad de innovación de las empresas de la industria del software de Jalisco, partiendo de una encuesta realizada a la empresas que componen el Centro de Software del Estado, además de evaluar la influencia que la capacidad de innovación tiene sobre su competitividad, buscando la evidencia empírica que permita dar respuesta a la pregunta formulada. La principal hipótesis que guiará esta investigación es la capacidad de innovar es un factor que incide positivamente en el desempeño de las empresas en la industria del software, lo cual se ve reflejado en la competitividad del sector. Los métodos usados en esta investigación son tres: Índice de capacidad de innovación (ICI), Modelo de Regresión Lineal con Mínimos Cuadrados Ordinarios y Soft Computing aplicando algoritmos evolutivos: FUZZY CESAR, siendo esta última algo muy nuevo que nos sitúa en la frontera del conocimiento en cuanto a métodos se trata.

Palabras clave: Competitividad, industria del software, innovación.

1. Introduction

The economic outlook is forcing companies to rethink their business, because the complexity of the environment is causing a progressive decline of many business models considered valid until recently. In some sectors, innovation has become an essential survival factor. But still for some companies, especially smaller ones, innovation is synonymous with complexity and ignorance, leading to a sense that is exclusive to large companies. The ability to innovate is a resource of the company like their financial, trade and productive capacities and should be managed in the same manner and with the same importance.

Moving toward a service economy with high added value and dynamics oriented towards innovation requires of an information and communication technologies (ICT) industry, more competitive and tightly integrated with other national economic sectors. In a globalized economy, built by information and knowledge, these are the primary software solutions for the problems facing the industry, academia and government. This is how the software industry offers new opportunities for economic and social development of countries (Secretaria de Economía, 2012).

The software industry in Mexico is relatively small and of little commercial development, based mainly on the production of customized software or standardized software adaptation to the needs of users. This lack of development of production of basic software, operating systems and applications, is expressed in the structure of national accounts of Mexico, who has not a section that allows socially account the magnitude of domestic production of such software (Mochi, 2006).

In this context, this research aims to analyze the competitiveness of the software industry in Jalisco depending on the capacity for innovation. It is intended to determine an index of innovation capacity to analyze and discuss the application of this indicator to a sample of 44 companies of the State of Jalisco as part of the Center for Software (Centro de Software) and likewise interested in evaluating whether firms with greater capacity to innovate have outperformed the market, which is reflected in the sector's competitiveness.

2. Problem

The technological advances that have occurred in recent years have generated and promoted many events and series of processes that many have defined as a new productive industrial revolution (Dabat, 2002). These events, as mentioned by Mochi (2006), are related to the emergence of a new stage of capitalist production, which is characterized by the increasing importance of technological innovation and knowledge as a major factor in generating value, in a context of economic globalization. In this scenario, the information and communication technologies (ICTs) have become very important. This is related to the development and increased use of multifunctional technology: Software. This has generated a major industry, whose key fields are software engineering and IT services (ISSI), which have a complex structure and require a great capacity for innovation.

The software industry in Mexico and Jalisco is going through a stage of maturity, which manifests itself in an increase in recent years. In addition to the generation of active public policies that are aimed at encouraging entrepreneurship and development of existing business, the promotion of technology and infrastructure (Secretaría de Economía, 2012). As Mochi (2006) argues, opportunities and challenges to consolidate the software industry make clear the need to convene, in order to exploit the advantages offered by this sector, for insertion into the international economy, and development of different sectors of the national economy.

It is important to also consider Jalisco as being the leading producer of embedded software in the country. Then, it can be said that, as noted by the OECD to Mexico, it is still competing in niches with low value added (OECD 2006), low innovation (Rodríguez 2010) and little expertise. Hence, the issues that it is intended to address this research depart from some work and international sources. From this, it is possible to draw a number of elements to determine an index that allows measuring the innovativeness of a representative group of the software industry in Jalisco. In order to study this is considered as a factor affecting performance companies in the sector, which it is reflected on competitiveness.

3. Research question

Does the ability to innovate is a factor affecting the performance of companies in the software industry Jalisco,

making the sector competitive

4. Theoretical framework - conceptual competitiveness

Studies on the competitiveness have been approached from two perspectives. One of them considers that organizations are open systems that are influenced by external factors over which the company has little or no control. From this point of view, the external environment will determine the success or failure of enterprises. However, Porter (1991) opined that the structural characteristics of the sector are unstable and that the behavior of these influences decisively. From another perspective, competitiveness is determined by the internal factors of the company. One theory that has come to support this idea is the theory of resources and capabilities of enterprises (Barney, 1991; Penrose, 1959), which argues that competitive success is due to the set of resources and capabilities it possesses and make it different from other competitors in the industry.

In this section, the focus of competitive forces of Porter is reviewed, for which it is important to consider that many countries, regions and industries are experiencing an economic situation whose key factors are different from those that were valid until a few years ago. In this new context, competitiveness is expected to play a key role. It has become one of the most important development concerns. However, this concept is still unclear, due to its generic nature and the wide range of elements that converge around it.

Be aware that competitiveness is rather the product of a pattern of complex and dynamic interaction between the state, enterprises, intermediary institutions and organizational capacity of a society. The competitiveness of a sector of economic activity is based on the organizational pattern of the society as a whole, the parameters of competitive relevance and interaction between them, which is, ultimately, interaction that generates benefits for the region. The factors identified as core are: innovation, knowledge and the close relationship between institutions, public, academic and private (Salazar, 2010).

A. Theoretical review

To clarify the concept of competitiveness it is necessary to specify in which field applies: countries (macro level), economic sectors at national and regional level (meso level) and businesses (micro level). Romo (2005) classifies these areas in what he called a hierarchical structure of concentric levels of competitiveness, as shown in Figure 1.

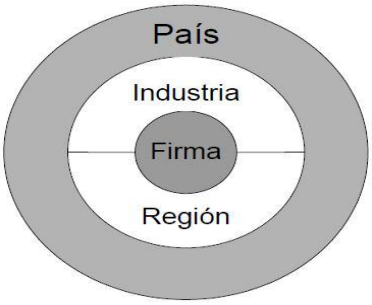

Figure 1: Economic levels
Source: Romo (2005).

Levels are represented graphically in the form of concentric rings to illustrate the idea that business competitiveness is influenced by conditions in the industry and region, while the competitiveness of companies, industries and regions is determined by national conditions.

i) Business scope

The meaning of the competitiveness of a company derives its competitive advantage in production methods and organization (price and quality of the final product) over its competitors (Romo, 2005). The ability to compete in a business is the ability to stay in the market, providing goods and services more effectively and efficiently than its competitors, generating returns on invested long-term capital. From the design, production and marketing of premium products, where superiority can be evaluated based on factors such as price and / or differentiation, quality and technological advancement and physical resources as company assets, capabilities, organizational culture, patents, trademarks, strategies, information and knowledge etc.

One of the ways in which competitiveness is measured is by its financial performance. Therefore, the existence of a good financial performance suggests that a company increases its competitiveness. The competitive performance can also be measured by the return on sales and assets and the value added per employee. There are separately nonfinancial indicators such as market share, the percentage of loyal customers, the percentage of loyal suppliers and staff turnover results. Costs, productivity and export capacity are also indicators of competitiveness. It should be noted that a single factor is not an adequate indicator of competitiveness.

Beyond the financial or market-based indicators, measures of competitiveness increasingly include other variables such as innovation, quality, management enhancements, and social and ethical duties and responsibility (Robeil, 2006). At the enterprise level among the factors contributing to competitiveness are: good management of production flows, raw materials and supplies, R & D, design, engineering and industrial manufacturing, cooperation with universities and other companies, developing strategies in response to demand and market developments and finally, the measures taken by companies to increase employee skills through training and the establishment of a greater degree of responsibility in production (Robeil, 2006; Romo, 2005).

In relation to the above Romo (2005) comments that apart from the relevant internal factors in performance competitiveness as the size of the business, labor productivity, total factor productivity, performance in exports, investment in R & D - in particular product, process and management capacity of innovation and human capital - external variables with significant effects on competitiveness are related to the following levels described by Romo (2005). The ability of firms to compete is conditioned upon the circumstances of the environment in which they operate, and the search for a favorable position in an industry company (Porter, 1996).

ii) Industrial scope

In an industry, understood as a set of companies engaged in similar business activities, competitiveness is derived from higher productivity, lower costs facing either to their international rivals in the same activity or through the ability to offer products with a higher value (Depperu, 2005; Estrada and Heijs, 2005; Romo, 2005) .The competition at this level is the result largely of the competitiveness of individual firms, but also the competitiveness of enterprises increased by the competitive environment prevailing in the industry.

Not all industries are the same, so their characteristics determine its competitiveness, features such as the nature of the goods produced, market concentration and entry barriers, capital intensity and technical complexity, maturity of the technology used, export potential, foreign presence and strategy followed by foreign investors (Romo, 2005). The competitive race between companies stimulates innovation, lower costs and improves the quality of products in the industry, causing demand increases.

iii) Regional level

For national and regional economic sectors and groups of companies (meso level), competitiveness is the ability of companies to achieve sustainable success against their competitors in other countries, regions or groups (Biggeri, 2007; Siggel, 2007). In the view of Porter (2009), the paths of the evolution of a sector depend, among other things, on strategic choices of firms. Also the performance and development of a company is determined largely by the prevailing conditions in their environment, especially those related to their immediate geographical proximity (Romo, 2005).

According to Romo (2005) once the business climate improves, companies begin to concentrate on specific geographic regions, forming clusters with the potential to positively affect competitiveness, especially through three mechanisms:

a) Increasing the productivity of constituent firms or industries,

b) Raising the innovation capacity and hence the productivity growth, and

c) Encouraging the formation of new businesses that expand the conglomerate

Therefore, the importance is to give greater support to innovation. The importance of geographical agglomeration is all this gives rise to the generation of so-called "external economies", which can be of two types: Technological and pecuniary. The first involving transfer and spillover of knowledge between companies, which contributes to the receiving party for technological capabilities that tend to, strengthen the competitive edge of the industry. The latter, includes the creation of a market for skilled labor and suppliers, which again tends to strengthen the advantage competitive industry (Romo, 2005).

iv) National level

Magda (2005) has commented that competition at national level is defined in terms of trade performance of countries, according to their comparative advantage. Meanwhile, Romo (2005) points out that the competitiveness of a country is defined as the share of its products in international markets adding diversification of the export basket, sustaining higher growth rates in these over time, increased technological content and skills in export activities, and expanding the base of local firms able to compete internationally.

Romo (2005) argues that countries in their competition to attract foreign investment capital must ensure stability, good governance and opportunities for profitable investment for investors. In this regard Robeil (2006) explains that the factors affecting the competitiveness of a country are:

1) The overall performance of the country (GDP, investment, employment, imports, exports and inflation).
2) Efficiency in government operations (public finance, fiscal policy, regulatory framework, institutional framework and social context).
3) The existence and quality of infrastructure (facilitation work, adequate transportation of people, goods and information).
4) The business efficiency (productivity, labor market, finance, management practices, values and attitudes).

Macroeconomic competitiveness from long-term perspective, it is considered as the ability of the economy of a nation to rapid and sustained increase employment rates, living standards of the population and the returns on investment, in terms of growth productivity (Estrada and Heijs, 2005; Magda, 2005; Romo, 2005). The differences in values, culture, economic structure, institutions and history of different countries contribute to their competitive success. Note that any country can or will be competitive in all or even in most industries (Romo, 2005). The analysis of competitiveness goes beyond macroeconomic variables that influence

structural factors affecting economic performance in the medium and long term, and are related to productivity and innovation. Technological innovation is important to support the economic growth and social welfare (Estrada and Heijs, 2005; Robeil, 2006; Romo, 2005).

Finally, the competitiveness of a country is the result of both the competitiveness of their companies, and the legal, economic and prevailing social conditions and public policy - monetary, exchange rate, fiscal, trade, finance, infrastructure, etc., and should be considered a relative comparison or benchmarking of performance to evaluate how well each participant has made in its development capacity to innovate and grow (Robeil, 2006).

5. Theoretical framework - conceptual innovation capacity.

In the new competitive scheme have become important some issues such as the ability of companies to adapt to the market environment, creating and / or effecting development and improvement of products and processes, and organizational changes for creating and sustaining competitive advantage, i.e. the agents aim to increase, what is called in this paper the "Innovation Capacity".

A. Theoretical review

The study of strategy advanced towards the paradigm based on resources and capabilities that a firm has (internal focus), or to be acquired to compete strategy. In short, it goes from an outside to inside approach when it comes to support the creation of competitive advantage.

i) Theory of resources and capabilities (RBV)

The theory of resources and capabilities becomes the precursor of knowledge management during the years 90s. A concept much more closely linked to business practice, this theory has received significant contributions from the field of business strategy over the past two decades. The determinants of success of the company have been a topic of central importance in the field of research in strategic management. In particular, various scholars have placed particular emphasis on the role played by the resources and capabilities that have these to achieve competitive advantages (Wernerfelt, 1984; Itami & Roehl, 1987; Barney, 1991; Teece, 1997; Pisano & Shuen, 1997).

In fact, Edith Penrose (1959) pioneered the development of the theory which states that a firm is more than an administrative unit; it is also a collection of ready productive resources between different users and over time, given an administrative decision. When looking at the business process of private business from this point of view, the size of the firm is better calibrated by measuring the productive resources it employs. The traditional concept of strategy by Andrews (1971) is formulated in terms of resources and position of the strengths and weaknesses of the company, while most of the tools in the formal economy operate on the side of the product market. While these are two perspectives, they ultimately should lead to the same idea.

Wernerfelt, in his paper published in 1984, mentions that for the company, resources and products represent two sides of the coin. He says that most products require the services of several resources and more resources can be used in various products. To specify the size of the company's business in different product markets, it is possible to infer the necessary minimum commitments of resources. The central discussion focuses on determining the attributes that must have the provided resources and capabilities in order to isolate the competition and enjoy special benefits for longer. In this thesis Barney (1991) identifies as key attributes that any resource should underpin to become a factor for competitive advantage for the company four main elements:

a. The resources must be valuable, allowing implement strategies to exploit opportunities or neutralize

threats.

b. Must be scarce or rare, arising from the mix of several combinations of physical and intangible resources, difficult to obtain in the factor market resources.

c. Have inimitable components, based on the presence of unique historical conditions, social complexity and causal ambiguity.

d. Difficult to substitute.

The only resources that are able to achieve these four attributes previously described are the intangibles such as a particular technology, accumulated consumer information, brand name, reputation and organizational culture and corporate culture. These assets are difficult to build and acquire because they require unique and complex conditions to be achieved, are dependent even the environment in which they operate. Itami and Roehl (1987) emphasize that intangible resources, such as a particular technology, accumulated information of consumers, brand name, reputation, innovation and corporate culture are invaluable assets to the comparative advantage of a signature. In fact, they claim that the "invisible resources" are often the only real resources of a firm to competitiveness can be sustained over time.

For its part Teece (1997), mentioned that since the resources are heterogeneous firms, the entry decision process suggested by this approach is as follows:

a. Identify the specific resources of the company.

b. Decide on which markets such resources can earn higher incomes.

c. Decide whether income assets are more effectively used by:

- Integration in the related market,
- The sale of the intermediate product to affiliates, or
- The sale of the assets themselves for a related company companies.

Summarizing, resources and capabilities essential guide strategies and contribute to achieve the potential benefits of the company, as presented by Grant (2006) in Figure 2:

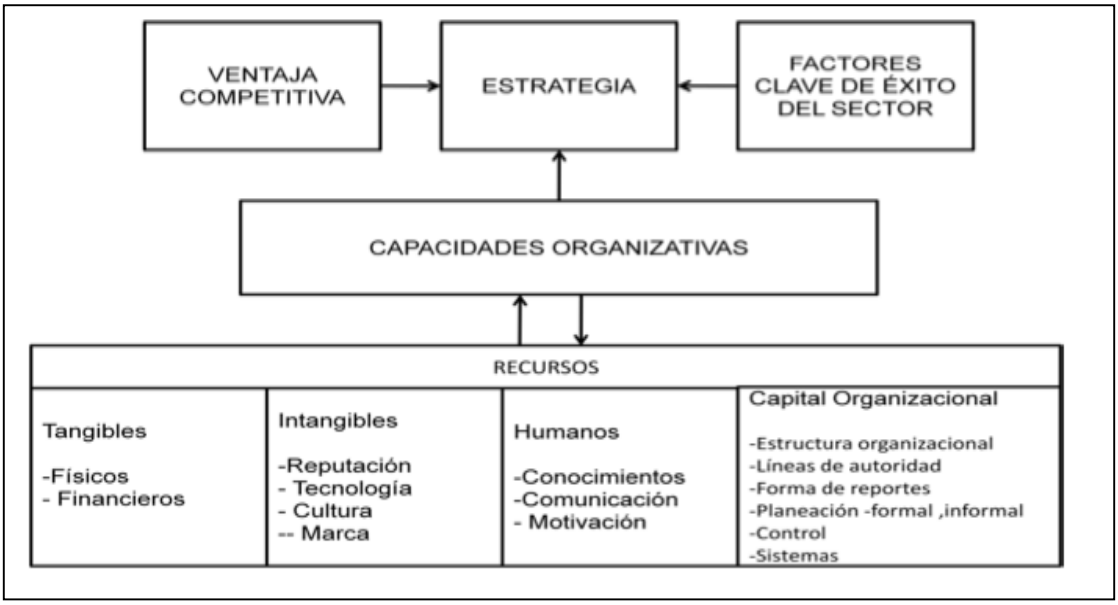

Figure 2: Relationship between resources, capabilities and competitive advantage.
Source: Grant (2006)

It is important to distinguish the concept of capacity, which is also useful to analyze the relationship between business objectives and use the resources that the firm possesses. The capabilities are the ability that allows resources to act jointly to achieve efficiently differentiate (Fong, 2005). The capabilities are created by everyday activity in the company, which has strong implications: are cumulative and are in the process of internal collective organizational learning. Capabilities are embedded in organizational processes of the company and are supported by the minds of the members of the organization. For this reason are socially complex (Fong, 2005).

ii) Theory of dynamic capabilities

In recent decades, the efficiency of the Theory of Resources and Capabilities has been questioned because in turbulent environments its approach is static. In this environment, there are key capabilities that enable rapid adaptation of company resources, allowing proper positioning and securing of unique resources to cope with the dynamism of business today. This extension of the prospect of Resources and Capabilities is what is known as the Dynamic Capabilities Approach (Teece, 1997). This view was proposed first by Teece, Pisano & Shuen (1997) and was later developed by Teece in 1997. These authors defined the dynamic capabilities as the ability of the company to generate new forms of competitive advantage from the reconfiguration of competencies or organizational resources.

In the environment of new businesses, time is considered a critical variable, the rate of technological change is very high and changes in the competitive environment and the markets are difficult to determine. The setting of such companies is characterized by high turbulence. In this situation, their success will be determined by the rapid adaptation of internal and external capabilities to achieve consistency with the changes that occur in the business environment capabilities.

The dynamic capabilities theory states that the company may increase its generation of potential benefits, if achieved distinctive resources and capabilities to develop forms, set strategies, accelerate the discontinuity of the same and direct the strategies of a contingently form (Mintzberg 1994 Peteraf, 1993; Hamel and Prahalad, 1994; Teece, 1997; Grant, 2006).

B. Innovation

Innovation is the creation or modification of a product, and its introduction into a market. An essential aspect of innovation is its successful commercially application. Do not just invent something, but, for example, introduce and spread in the market so that people can enjoy it. Innovation requires awareness and balance to carry the ideas, from the imaginary or fictitious field, to the field of embodiments and implementations.

The concept of innovation that is used for this research, depart from a broader vision that includes the set of interconnected changes made in different areas of a company and aimed at improving their competitiveness and economic efficiency (Yoguel & Boscherini, 1996). Therefore, from this perspective, innovation not only reduces the isolated activities to develop new products and processes, but also involves the set of developments and incremental improvements in various areas (organization, marketing, production, etc.) and activities aimed at developing quality.

Beyond development activities planned ex-ante, innovations are also generated from various routine activities undertaken in the firm that are not necessarily linked to the productive area (Ernst and Lundvall 1997). The interaction of staff of the company, the continuous exchange of views to solve problems or to face new situations and responses that arise and are used for the company to operate and improve economic efficiency, are an important source of inputs for development of innovative activities (Yoguel and Boscherini 1996). Yoguel and Boscherini (1996) mention that the development of innovative activities is a necessary condition but not sufficient to ensure good economic performance.

Early work on innovation dating back to the first half of last century, when Schumpeter (1934) conceptualized the entrepreneur as an innovator, since then, many authors have argued that innovation is a source of growth. For Schumpeter, innovation of enterprises is the driving force behind sustained economic growth in the long term, although the road can destroy the value of established companies. For this reason, the study of strategy advanced towards the paradigm based on resources and capabilities that have (internal focus), or to be acquired to compete strategy. In short, it goes from an outside to inside approach when it comes to support the creation of competitive advantages.

The theory of resources and capabilities becomes the precursor of knowledge management in the 90s, a concept much more closely linked to business practice. This theory has received significant contributions from the field of business strategy over the past two decades. An alternative to face this reality is innovation. The firm must seek new market niches, redefine the commercial horizons, stop competing to win the same customers and work with no customers, who are those who prefer competing products. Schumpeter defines innovation as the time when a new product, process or service is introduced in a specific market (Cardona Trevino, 2011).

i) Process innovation

According to Yoguel & Boscherini (1996), in the process of innovation, it comes together different knowledge and skills that are present in different areas of the company, whose use depends on the organizational culture of the firm. That is, the modalities and characteristics assumed by management and criteria that guide the decision making process. Over time, the interaction between this set of factors is generating a wealth of skills, often intangible and specific firms that determine their capacity for innovation.

Innovations are also generated with daily activities in the company, so it is very important the feedback that can be given to developing these activities that promote innovation within the firm. From this perspective, there are strong interactions and links between the decisional process and innovation activities. I.e. innovative activities are a prerequisite for any strategic decision related to the management of the firm and have impacts and consequences on all activities in the company. However, the full utilization of the results of innovative activities basically depends on the capabilities of the company to develop and conduct (Yoguel & Boscherini,

1996) consistent competitive strategies.

In this direction, it is observed that the innovative process in companies is multidimensional, being able to differentiate two levels that influence not only the importance of innovative activities, but in different forms and responses under which they occur. First, it emphasizes the set of elements located at the micro level and, secondly, the environment, i.e. the socio-institutional environment and its influence on the process of building skills. Both planes are linked from the set of interactions between the actors involved.

Finally, Yoguel & Boscherini (1996) conclude this review by saying that the process of innovation in firms can be seen as the result of the dynamic interaction of skills developed over time, learning that is generated and culture organizational under a certain atmosphere. That is, innovation is a learning process aimed at solving business problems and improves competitive positioning in the market. It is influenced and, in turn, affects the powers of the firms, which depend on the dominant organizational culture.

ii) Capacity for innovation

As mentioned, for purposes of this research, the concept of Innovation Capacity is defined as: the potential of combining effectively the set of resources and capabilities of the company to improve and create new knowledge. This section will describe the theoretical foundations that support this definition and underpinning the approach proposed to achieve the objectives.

In this context, the concept of innovation used, arises from a broad vision that involves the interconnected changes made in different areas of a company and aimed at improving its competitiveness and economic efficiency. Therefore, it is important to emphasize that staff interaction between different areas that make up the company, the exchange of views, among others, constitute an important source of inputs for the development of innovative activities (Yoguel and Boscherini 1996).

In developing its "innovative capacity", the production and development of this knowledge into the firm is a dynamic, continuous and cumulative process, amending and recreating the organizational and technological static skills. Thus, learning - both individually and collectively - plays a central role and determines that the powers are moldable dynamic resources in accordance with the strategic vision of the company. In sum, over time, the interaction between this set of factors is generating a wealth of skills, often intangible and firm´s specific (Hamel & Prahalad, 1994) that determine and condition their innovative capacity. Given the theoretical analysis guidelines that arises, proposed concept in this research on capacity to innovate concept is supported by three theories that have already been described:

a. Theory of dynamic capabilities (Tecce, 1997).

b. Theory of intangible assets (Prahalad and Hamel 1994).

c. Evolutionary theory (Nelson and Winter, 1982).

It is the existing studies on the subject there are several proposals on the various factors that can be expected to contribute to the accumulation of innovation capacity, same as most authors have grouped into: internal factors and external factors. As mentioned, internal factors occur mainly by the interaction of internal company resources in an effort to adapt to dynamic business, which through knowledge are developing innovations that are capitalized. According to evolutionary theory (Nelson and Winter, 1982), interaction with external factors provides a boost to survive and compete for improving organizational learning and experience. As a result, technological innovation is essential for a company to acquire and maintain competitive advantage and improve performance in a dynamic environment.

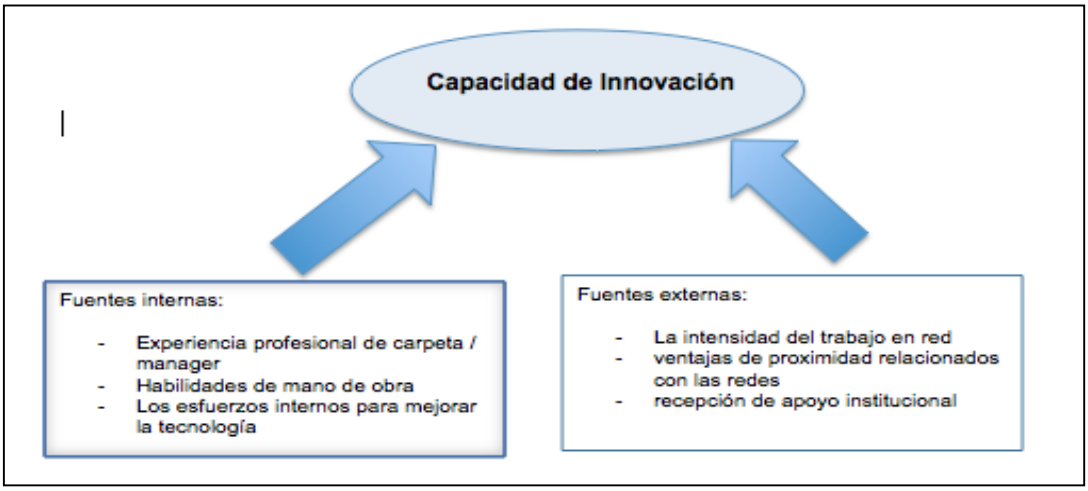

Figure 3: Innovation capacity: Internal and external factors
Source: Romijn, H. & Albaladejo, M. (2002)

iii) Innovation capacity index

This research arises from determining an indicator of innovative capacity, which was designated as the Innovation Capacity Index (ICI), same as it was proposed by Yoguel and Boscherini (1996), who considered qualitative and quantitative elements. The authors start from the idea that the generation and dissemination of knowledge, both internal to the firm as that between firms is a complex process positively associated with the need to solve problems under uncertainty, to the demand for solutions not easily codified to the degree of development of skills of human resources of the firm, to how the work process and the degree of importance to the firm's interpretation and adaptation of external codified knowledge is organized. This set of factors makes the tacit knowledge in particular, specific and non-appropriated elements by other agents, which is done through what is known as organizational learning.

Therefore, to increase the innovative and competitive capacity, it is needed to transform the information into knowledge, whereby entities, large or small, public or private, disseminate and exploit it. Within the perspective of organizational learning as change there are two streams. The first organizational learning is understood as an entity to make changes in order to adapt to its environment (Hedberg, 1981, March & Olsen, 1976, Duncan & Weiss, 1979). The second, like stocks that institutions make to transform and change their environment (Swieringa & Wierdsma, 1995, Kim 1993)

The organizations of the first type are concerned about survival and their greater efforts are aimed at solving the problems of everyday life, so that their stay in the market is preserved. The second are interested in their surroundings to intervene innovatively to position new products or new services, first that competition (Castañeda, 2004). In this direction, Yoguel & Boscherini (1996) mention that traditionally used indicators (research and development, patent number and publication of scientific articles) have been criticized not because explain the proper behavior of companies and countries with reduced expenditure on research and development (R & D) which led to have a significant industrial growth and improved their competitive position without making a long formal attempt in innovative activities.

Neither the number of patented inventions is viewed as a suitable indicator for measuring the intensity of innovative firms (Grilches 1990, Malerba & Orsenigo 1993). Indeed, the weakness of this indicator is not necessarily an invention results in an effective innovation, i.e. the introduction of any product, process and / or service in the market. Furthermore, patents do not take into account the knowledge that enterprises buy

"privately" by other means (tacit knowledge, learning, imitation etc.), undervaluing innovation activities informal type, especially in SMEs play a significant role (Santarelli & Sterlacchini 1990). In addition it is important to mention that in Mexico the software is not patented.

Therefore, the indicator of innovation capacity of agents aims to assess: i) the development of the skills of the agents ii) or Innovative Product Innovative and iii) the degree of movement of knowledge from formal and informal links developed with other agents and institutions in the territory in which they are located.

Yoguel & Boscherini (1996) mention that the current configuration of innovation capacity index (ICI) is the result of a previous work. The old indicator was a first attempt to evaluate the process of innovation in SMEs using variables that do not necessarily reflect the inputs and outputs of the innovation process. The indicator used in this study contains two important changes that allow a closer approximation to the relevance of the innovative activities of SMEs. The first difference comes from the replacement of some of the variables considered and the inclusion of more appropriate for evaluating innovation capacity. The second change involves introducing weights for the variables. In the previous indicator variables were not given any weight because innovation capacity from a simple average of the variables was estimated. Therefore, equal influence was assigned to each variable in the innovation capacity of enterprises.

The introduction of a different weight for each variable differential reflects the importance of acquiring the various elements in the formation of skills. In this sense, the current structure of ICI is the result of simulations using different weights. Innovation Capacity Index (ICI) attempts to measure and give a synthetic approach of existing capacities in a company for innovation and the characteristics of the innovation process. The ICI is an indicator that evaluates the potential of innovative firms. Note that making the measurement is a measurement ICI relative and not absolute. The innovation capacity of individual firms cannot be compared directly with that of companies operating in different environments economic and historical contexts.

Innovative capacity indicator or innovation proposed by Yoguel and Boscherini (1996), which is used in this research, it is a weighted average of 6 factors. Quality assurance, training efforts, scope of development activities, and participation of engineers and technicians in the development team, the first four factors are associated with the development of skills of the agents are estimated. Is also have been considered a factor which points to measure the innovative product which it is estimated from the weight of new products introduced by the firm in billing innovative product. Finally a proxy for the degree of movement of knowledge is included.

Thus, the indicator of innovation capacity of the company is expressed as:

$$ICI = \sum \alpha i * Fij$$

Where:
ICI = Innovation Capacity Index

ai = weighting assigned to each factor

Fij = Factors component of the ICI

In the table below, the weights assigned by the authors Yoguel and Boscherini are listed, for the calculation of the index of innovative capacity, which shows that the high aggregated weight assigned to the 4 factors associated with the development of the skills of the agents it follows directly from the theoretical framework explicated by the author. It also the author mentions that it was found that the ordering of the firms according innovation capacity is not significantly modified to changes in the weights assigned to the factors (Yoguel and

Boscherini 1996).

In table 1, the authors explain how to construct each of the factors differentiating between those associated with the development of skills (training efforts, the degree of quality assurance, participation of engineers and technicians in development teams, scope and degree of development activities), the innovative product (weight of new products in turnover) and the circulation of codified and tacit knowledge from various mechanisms of formal and informal cooperation.

Table 1: Weighting factors of innovation capability index

FACTOR	PONDERACION
DESARROLLO DE COMPETENCIAS	0.77
Esfuerzos de Capacitacion del personal	0.25
Aseguramiento de Calidad	0.25
Alcance de las actividades de desarrollo	0.2
Peso de ingenieros en equipos de desarrollo	0.07
PRODUCTO INNOVATIVO	0.08
Peso de nuevos productos en la facturación	0.080
CIRCULACION DE CONOCIMIENTO	0.15
Cooperacion tecnologica formal e informal	0.15

Source: Yoguel & Boscherini, 1996.

C. Factors associated with the development of skills

The factor "staff training efforts" made by firms aimed at developing technical "competencies" assesses the proportion of staff involved in courses oriented toward quality assurance and the search for new developments. All these are reflected in the importance of training personnel according to the employer´s criterion that was applied to the assessment of this factor in this research.

The degree of quality assurance factor achieved by the firms is evaluated from a set of sequential elements that refer to the existence of quality control over production process, the use of quality control instruments in development of products, the use of forms of control checkpoints and complexity of the estimated by "statistics". Complementing this, it is achieved a set of control questions that allow to check the degree of reliability of responses. For purposes of this research, the analysis of this factor was limited to the fact of whether or not the company has any certification on quality, which was considered it includes the criteria originally defined by the author.

The degree of importance of engineers and technicians in the group dedicated to developments, both formal and informal is an estimator of the qualification of "team" of development and the complexity of the tasks that may be involved. In that sense, a gradient of situations ranging from the absence of this type of ratings to the cases that account for a significant proportion of the team is built developments: In this direction is estimated ratio between the number of engineers and technicians dedicated to quality work and developments in total employment in the formal or informal teams dedicated to these tasks in the firm.

1) Factor considering the innovative product

The weight of new products in billing is an approximation of what is called in the literature the innovative product. This factor points to evaluate the importance achieved by the introduction of products containing technical improvements and / or is new to the firm. For purposes of this research, three aspects are evaluated:

Development of new products and services, design modifications of existing products and services and technological conversion products and services.

2) Proxy Factor circulation of knowledge

Given that a significant part of the required knowledge to carry out development activities have a significant tacit component, its movement and its internalization by the agents need a support of formal and informal linkages. The development of these links, which contribute to changing routines, movement of informal knowledge and skills development can be seen as an evolutionary process that requires as a starting point the existence and / or the development of mutual trust between agents to facilitate such dissemination. In this direction, the indicator of technological cooperation is a proxy that attempts to measure the degree of development of the interactions of local agents aimed at generating technological, business and learning skills.

In that sense, they are proxy indicators of environmental performance both formal and informal links that organizations perform with other agents, such as firms, consultants, public and private institutions, universities, etc., to:

i) Develop and improve products and processes.
ii) Changes in the organization in the management of the company,
iii) Modify the distribution channels, and
iv) Improving and developing quality management.

Since the confidence intervals associated with each value of the 6 factors described alternatives correspond to ex ante indicator results referred innovative capacity can be compared in the various panels used and estimated panels used in other investigations. Thus, each firm is assigned a level of innovative capacity that is an equivalent result to the weighted average of the scores assigned to each of the six factors considered.

D. Empirical review for innovativeness and competitiveness

There is still little empirical evidence on how it can be determined the innovativeness capacity of companies. It has not been reached a consensus in the scientific community about a method, being a relatively new concept and it is very qualitative. Despite this, there has been a literature review so it was decided to apply the proposed Yoguel and Boscherini (1996) to determine the rate of innovation capacity of enterprises. It is the same that has already been already implemented by some researchers. It follows is a brief summary of the methods used, results and findings.

In 2001, Yoguel and Boscherini, after the proposal made on calculating the rate of innovation capacity in 1996, years later (2001), they applied their model in their work entitled "The Development of Innovative Capabilities of firms and the role of territorial system", where they raised as central objective of their work to present a proxy indicator of the agents potential to learn, and create competencies, transform generic knowledge into specific and therefore innovate. That is, trying to analyze the wealth of knowledge of the business, and in particular the methods that they use to acquire, organize, process, store and transfer information (technical, organizational, etc.), which contributes to increase their knowledge base.

The authors applied this indicator to a panel of 245 Argentinian companies, including the ones dominated by small and medium business located in areas with mixed generation of externalities. The authors note that their research also aims to assess to what extent the size of the agents and the degree of development of the territorial system, i.e. the socio-economic and institutional environment in which companies operate constitute significant elements for understanding the differences in innovativeness capacity. Finally, the authors were interested in assessing whether firms with greater capacity for innovation have had a more dynamic

performance in the market that the remaining from the process of opening up the economy and structural reforms.

The conclusions reached by the authors are:

- The existence of a positive association between the development of innovative capacity of firms and the size.
- The work has shown that in environments where positive externalities prevail, institutional development seems to be an important determinant of the level of innovativeness achieved by agents.
- The existence or not existence of association between the size of the agents and the development of innovative capacity could be thought of as a proxy for development of the local environment.

In 2003, Velasco & López, Pontifical Catholic University of Peru, conducted a study entitled "Innovative Capacity of Peruvian SMEs in APEC Universe", which aimed to develop an Innovation Capacity Index (ICI) that allow to establish the degree of efficiency and finding new markets, factors which may affect the export potential and level of profits of SMEs. Furthermore, the study aimed to assess the impact of business development services (BDS) on the level of profits and production. In the methodology of their work, the authors based the calculation of Innovation Capacity Index Innovative Capacity or as they call it, in the proposed Yoguel and Boscherini (1996) model, besides using an econometric model to evaluate the relationship between the ICI and the level of utility and production, reaching the following results:

1. SMEs that export increased their level of earnings by about 1%; in addition, for every percentage point increased an SME innovation in terms of ICI, level of profits grew by about 1.4%.

2. The elasticity of the utility on the number of workers is 1.2 approximately. The age of the company almost no has effect; assets of SMEs increased by 2% profit if they grow by 10%; and in respect of industries, SMEs belonging to the branches of electricity, gas and water (very few), the business services and wholesale trading are those with more profits respective to the rest.

And reporting the following findings:

1. The ICI built it affects the ability to export, although the level of significance is not entirely solid.

2. It is noted that there is a weak relationship between the ability to innovate and export, similar to Yoguel and Boscherini result (1996) to the Argentine case.

3. The built ICI was also positively correlated with the levels of profits of SMEs.

In 2009, Hernández, in his thesis presented at University of Guadalajara entitled "Capacity of innovation in software companies. A comparative study between Guadalajara and Tijuana" took as a case study companies that are part of the software industry in Tijuana and Guadalajara. The differences between the two Mexican cities were analyzed, both in form and manner in which they were born and in structure today. It was weighted and pondered the differences between the detonators competitiveness factors and their relationship with economic variables such as sales, size, and the fact that they are exporting or not.

The methodology proposed by the authors, was to use the survey conducted to Software companies in 2006, to calculate an index of innovativeness applying the model proposed by Yoguel and Boscherini in 1996, and then make a linear regression with OLS to determine how they affect sales, size and state Innovativeness.

The results were:

1. The companies have a skill level above the average considered ideal.
2. The relationship between sales and Capacity for Innovation is negative, which it explains the author may be due to the existence of a linear relationship between sales and company size and same that causes the largest companies size having consolidated its market by reducing their levels of innovation. In fact, the size variable was not significant and was dropped from the model.

A summary of the empirical studies that have been described and considered most relevant to take the focus of this research is:

Table 2: Summary table of the empirical review.

Author	Country	Object of Study	Sample	Methods
Yoguel Y Boscherini (2001),	Argentina	Argentinian companies	275	ICI calculus, Multiple regression with OLS
Velasco & López (2003)	Peru	SMEs	379	ICI calculus, Probit regression
Hernández (2009)	México	Software firms of Guadalajara and Tijuana.	NA	ICI calculus, Multiple regression with OLS

Source: Own elaboration.

6. Software industry.

The software industry's main producer and consumer in the global scope is the United State (US). Countries like Ireland, India and Israel have reached a growth and integration into international markets. It can be mentioned a late insertion as a result of the dynamism of the software industry, the entrant countries such as Taiwan, China, Singapore, Thailand, Korea, Malaysia, the Philippines and Vietnam. They are also taking an interesting development, although clearly much more limited than in the countries mentioned, some Latin American countries like Brazil, Argentina, Uruguay, Costa Rica and Mexico (Mochi, 2006). Is complex to adopt a concept of software due to the intangible nature of the products and in part to the constant technological changes, making it difficult to determine whether it is a product or a service. Mochi (2006) mentions that it can be said generally, that the Software is codified knowledge and information.

The most common definition proposed by the Organization for Economic Cooperation and Development (OECD) and similar to those used by the International Standardization Organization (ISO) and the Word Intellectual Property Organization (WIPO), says that software means production of a set of instructions, procedures of a structured instructions, procedures, programs, rules and documentation in different types of media (tapes, disks, electrical circuits, etc.) in order to make the use of equipment which might set electronic data processing (EDP) (OECD, 1996). In terms of competitiveness, the World Economic Forum (WEF) (2012) in its publication "Global competitiveness Report 2012-2013" places Mexico in the position number 53 of 142 countries.

In one of its pillars, this index ranks "Efficiency enhancers" or boosters efficiency in which technological readiness, technological readiness, is one of the sub-indices analyzed. Mexico ranks number 63 which puts the country in a position that almost reaches the average of the sample. The indicators mentioned are merely the result of the countries of Latin America that have not had state government policy made public in order to know their pronouncements on social information, except Mexico that is having a consistent work since the early 90s. But today is marked by numerous agreements and partnerships for the development of new technologies on the continent.

It is also important to mention that Mexico has a backlog in the use of information and communication technologies. It ranks 76 in the world list of Information Technology 2012 which is given by an index composed of four sub-indices measuring the environment for information technology and communication (ICT), the willingness of society to use ICT, the actual use of all the main actors and, finally, the impact that ICTs in the economy and society. These four sub-indices are divided into 10 columns and 53 variables according to the following structure (WEF, 2012).

The software industry in Latin America also has partnerships through different integration initiatives. These partnerships aim to promote policies, improving markets and supply chains, to help its partners to improve their competitive capabilities and seek alternatives for development of joint programs based on mutual benefit. Mexico counts on the Mexicana Industry Association of Information Technology (AMITI) created in 1997 which has more than 180 member companies. Other Mexican alternatives is The Mexican Association for Quality in Software Engineering (AMCIS), formally established in 1999 in order to ensure the quality of IT processes generally that allow it to ensure its international competitiveness and meet the international quality standards in the software production.

Mexico also developed the Process Model for Software Industry in Mexico (Prosoft) in 2003, which is the Mexican industry standard for developing and maintaining software for small and medium enterprises. This model is compatible with CMMI, ISO 9000: 2000 and ISO 15504. Moreover the ESI Center Mexico, home of the European Software Institute (ESI) in Guadalajara and Monterrey offers training, consulting and evaluation in CMMI, ISO 9000, ISO 15504 and offers a Diploma in Software Quality. Mexico´s intentions to surfing on the wave have produced a wealth of ideas between the public sector and producers of software. This materialized in the Program for the Development of the Software Industry (Prosoft). The debate has been very intense, because many of the participants see in the reproduction of export model from India, Ireland and Israel a development option, while others advocate a more domestically oriented model.

This discussion of information technology for development is an update made in the late eighties, when the outwards development was considered a formula to solve the problems of growth. From this perspective it is necessary further to show that successful cases are just an entry point, in no way the only valid for industry development option. Each follows a particular history of industrial, technological and business development that has driven its viability in the global economy.

A. Software Industry in Jalisco

In the case of the software industry in Guadalajara, the origins of this industry date back to early 2000, when Jalisco began to resent the slowdown in the electronics industry. This crisis caused that twenty seven companies closed operations in the period 2000 to 2004. These external phenomena were the incentive for the state government, through the State Council of Science and Technology (COECyJal) announced the promotion of the software industry as a way to convert the industrial state economy. These objectives were set out in the (PECyT-Jal) State Science and Technology Plan 2001-2007, published in early 2003. Then, from the guidelines and strategies of Prosoft, and derivative of the objectives of PECyT-Jal, it was promoted, since 2003, the State of Jalisco Software Program (PROSOFTJAL) with the support of the National Chamber of the Electronics Industry, Telecommunications and Information Technology (CANIETI).

Jalisco accounts since the late nineties, with favorable environment for the development of the software industry. On the demand side, the company already had, from the sixties to the cluster of electronics, a market dominated by large subsidiary of transnational corporations and smaller companies operating with domestic capital as suppliers of products and specialized system components. On the supply side, Jalisco had more than ten universities, all with programs related to information technology, electronics, microelectronics,

mechatronics and telecommunications.

In 2001, 27 companies formed an integrative company known as Aportia, which was intended to increase individual and collective entrepreneurial skills based on CMM (Capability Maturity Model) and attract projects and resources together (Jaen & Hernandez 2009) which formed an innovative and important precedent association and organization for the state. In 2004, a group of entrepreneurs, along with COECyT, began to develop a project that aimed to create a Software Center, the first in the state. On September 28, 2006, by tripartite initiative it was established a Software Center in the state of Jalisco.

1) Territorial delimitation

The research study is delimited Software companies of the state of Jalisco, which are located in the Software Center State.

The Software Center of Jalisco was inaugurated on September 28, 2006 by President Vicente Fox Quesada. The Software Center is a joint project of the federal government, through the Ministry of the Economy (2012) and the Prosoft fund and the Government of Jalisco through COECYTJAL. The center has capacity to accommodate 52 software development companies, which provide about 700 jobs of added value, 65 percent for developers (Software Center, 2012).

Figure 4: Location of the Software Center in Guadalajara.

Source: Own elaboration.

The business focus of these software developers can be divided into the following categories:

a) Applications Web and multimedia

b) Business applications and IT services, education
c) Specialized consultancy
d) Consulting for quality systems in information technology
e) Factories software outsourcing and offshore
f) Software testing
g) Testing of embedded systems

The objectives of the Software Center are to host small and medium enterprises engaged in software development and provide them with a common infrastructure to take advantage of working together, creating a synergistic model of high value, to promote growth of the Technology Information Sector, Microelectronics and Multimedia, to increase the competitiveness of strategic sectors of the state through the adoption of information technology in their business processes and promote the formation of specialized human resources in areas of engineering. It is a collaborative effort between government, academia and the private sector to enrich the area, positioned to host the high technology sector of the country.

Among the projects in which the Software Center is currently working, there is an agreement with the IPv6 Task Force for joint research and development with other business center. This project aims at the promotion, dissemination and development of the second generation Internet, a necessary migration for many companies worldwide. Agreements with RIM (Research In Motion) are also developed for the development of applications compatible with computers Black Berry® through integrative Aportia with Intel to develop joint applications.

Among the services for the developer companies the Software Center include:

a) Support and guidance in connection with other companies with whom they can exploit business opportunities together.
b) Crossed sales as a result of this constant interaction and references for prospects.
c) Linking with the Academic sector in providing a competitive human capital formation
d) Interaction with larger companies in the electronics industry, information and communications technology who serve as suppliers for different projects.
e) Approximately 10 thousand square meters of facilities which include offices, communication infrastructure, security, and common multipurpose rooms.

Among the services for clients are included:

a) Integration of IT services and products.
b) Multidisciplinary integration to provide complete solutions that involve the participation of multiple companies, skills and products, the Software ecosystem tropicalisation.
c) Modifications, translations or certifications of various programs for the Mexican market, in order to facilitate market entry; likewise to foray into other regions of Latin America.
d) One Stop Shopping, a mixture of different products, solutions and services companies in the Centre, in order to meet specific requirements.

Within the versatility and different twists to companies that integrate the Software Center engaged government, educational, nutritional, pharmaceutical, health, agriculture, construction, finance, footwear and care sectors.

B. Purpose of study

The research is focused on studying the capacity of innovation in the software industry in Jalisco. Therefore, it can be defined the object of study, which is composed of a significant sample of the software industry that consists of 44 of the 52 companies in the state Software Center

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