Model for Determining the Absorption Capacity of SMES in the Manufacturing Sector

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Abstract

This research aims at creating a model to determine the level of absorptive capacity in SMEs in the manufacturing sector through four dimensions (investment in R&D, number of patents, company structure, staff training); some authors propose measuring these or other variables separately, but based on the reviewed literature, the proposed model includes dimensions comprehensively identified as the most relevant, and the variables that allow a more accurate measurement absorptive capacity. It is important to underline that for the last ten years the research on this subject is being conducted mainly in countries of Asia.

Keywords: Absorptive capacity, innovation, manufacturing sector

Introduction.

Organizations have come to rely on innovation as the primary source of competitive advantage (Rosdi and Kok, 2010; Davis, 2013); also is paying increasing attention to the role of innovation in promoting growth, development and driving productivity and competitiveness (Hsu and Sabherwal, 2011; Sambharya and Lee, 2014). For Lopez, Forestry and Vazquez (2012), the innovation output is associated with a number of inputs that must identify and understand how they relate.

Among all the inputs that relate to innovate, Prajogo and Ahmed (2006) and Schwab et al. (2011) mention that innovation capacity is the most important; as defined by Bell (2009), it is necessary capacities to imagine,

develop and implement innovations in products and services the economy produces, and how that occurs.

Obtaining innovative ideas increase the ability of the company to identify, assimilate and exploit the knowledge available outside its borders, increase their absorptive capacity (Vega, Gutierrez and Fernandez, 2009), which directly impacts their innovation (Hemert, Nijkamp and Masurel, 2013) and the development of new products (Kotabe et al, 2011; Sharif, M., 2012).

The absorptive capacity is one of the most important concepts developed in business research in recent years (Hurtado, A. Gonzalez, C., 2015); because this capacity has influence on the innovative capabilities of the company (Dutse, 2013); Zhixiong and Yuanjian (2010), determined that this concept is critical in attempts made by companies to use external knowledge to promote and maintain continuous innovation. Roshartini, Takim and Nawawi (2011) noted that in the real world, companies cannot assimilate and successfully implement external knowledge without a high level of this ability, which is why worth exploring its variables or critical components.

Despite the evolution of the role within the economy, large and small and medium-sized (SMEs) companies, which has favored the SMEs to have a much more prominent role, when the absorptive capacity was launched between 1990 and 2005, it focused mainly on large companies, but since 2006 there has been increasing interest on the inclusion of SMEs in these studies, because of their importance to the global economy (Jimenez, Angelov and Rao, 2010).

Small and medium enterprises make up more than 99% the business universe in the world (Padilla, 2008), they are considered as one of the main engines of an economy (Philip, 2011).

Regardless of the country in which they are located, SMEs face problems concerning their survival, or to obtain a competitive advantage (Khalique et al., 2011). The failure of these figures are worrying, in the case of Mexico 75% of new businesses are forced to cease operations after two years of activity; in Argentina 93% does not reach the second year and 97% disappear before the fifth; in Spain 80% of these companies go to bankrupt in the first five years; in the United States the average life of companies is six years and more than 30% does not reach the third; in the case of Chile, 25% disappeared in the first year and 66% cease operations in the first four years (Velázquez and Reyna, 2009).

For Philip (2011), the most important factors that influence the success of SMEs include: management and know-how, products and services, the way we do business and cooperation, resources and finance, and the external environment. Khalique et al. (2011), believe that the challenges

we must overcome a company of this type are: the recession, the barrier global supply, low productivity, lack of management skills, lack of funding and access to management and technology, without ignoring intellectual capital as a critical factor for the success of organizations.

Ropega (2011), indicates that the main problems in these organizations include lack of business plan by 21.7%, lack of staff training by 20.4%, particularly in the area of human resources and reduced quality products or services with 34.5%, in the area of technology and innovation.

Dong (2010), states that SMEs cannot develop without technological innovation and stresses the importance of innovation to improve competitiveness in the development of new products and the second innovation. Not only innovation from the technological point of view, but also the integration of cultural innovation, management innovation and technological innovation including technology import, innovation, imitation and independent cooperation of innovation. Spiegel and Marxt (2012), point out that the ability to continuously innovate is widely recognized as one of the basic skills for successful SMEs.

SMEs are more vulnerable to globalization and rapid technological change because of their limited resources, limiting their access to funding sources and their possibilities for recruiting talented human resources. The advantage of their behavior lies in its strengths related to the flexibility, responsiveness to market needs and their ability to meet customer demand. The absorptive capacity of small and medium businesses determines their access to knowledge and plays a key role in their ability to explore and exploit opportunities in their environment (Valentim, Verissimo and Franco, 2015).

Consequently, this study makes a theoretical review of the study on absorptive capacity, analyzing approaches and models that state the importance of absorptive capacity, its impact on innovation and proposals for measurement; after the authors propose a model for measuring the absorptive capacity, and finally in the last section, final reflections are raised as conclusions.

Absorptive Capacity Background.

Li and Chen (2010), the capacity for innovation involves types of resources and skills in the business including technology, strategy, knowledge, processes and organization; with a high level of innovation capacity, the company is able to improve products and processes, develop new ideas and turn them into new products, processes or systems; 7 elements that define emphasizing innovation capacity: 1. Vision and strategy; 2. Harnessing the basis of competition; 3. Organizational intelligence; 4.

Creativity and management ideas; 5. Organizational structures and systems; 6. Culture and climate; 7. Management of technology.

For companies to achieve greater competitiveness through innovation, it is important sharing knowledge and presence of cooperative relations based on knowledge. For this reason, companies must develop their ability to innovate looking for ways to generate and integrate knowledge, i.e. through its own absorptive capacity. This capacity leads to effective innovation processes and recognizes the value of external knowledge for this purpose (Gonzalez and Hurtado, 2014).

The concept of absorptive capacity was introduced by Cohen and Levinthal in an article published in 1990 in order to better understand organizational learning in enterprises; which it was defined as the ability to recognize the value of new external information, assimilate and apply for commercial purposes (Gold, Malhotra and Segars, 2001; Vega, Gutierrez and Fernandez, 2009; Chen and Xu, 2010, Jimenez, Angelov and Rao, 2010; Kotabe et al, 2011; Rodriguez and Brown, 2012; Junni, P. and Sarala, R., 2013; Patel et al, 2014).

Also these authors distinguish between the absorptive capacity at the individual level and the absorptive capacity at the organizational level, and highlighted the role of internal mechanism of the company in promoting communication and relationship between its members as an organizational aspect distinctive their absorptive capacity (Z. and Pandin M. Hutabarat, 2014); emphasizing the cumulative nature of the absorptive capacity and the notion that the company needs appropriate knowledge before using new knowledge (Valentim, Verissimo and Franco, 2015).

For Flower, Oltra and Garcia (2011), the absorptive capacity is one of the fundamental processes of learning in a company as long as reflects its ability to identify, assimilate and exploit knowledge of the environment; therefore, develop and maintain the absorptive capacity is critical for its survival in the long term of an organization.

Evolution of the concept of absorptive capacity.

Zahra and George (2002), reviewed reconceptualized, and extended the concept to see the absorptive capacity as a set of routines and organizational processes by which firms acquire, assimilate, transform and exploit knowledge to produce organizational skills dynamic; This concept has two stages and four dimensions: potential absorptive capacity, which includes the acquisition and assimilation of knowledge and realized absorptive capacity including transformation and exploitation of knowledge.

The absorptive capacity is the ability of the company to use the knowledge that externally possess through three sequential processes: (1) recognition of new knowledge, potentially valuable insights outside the

company through exploratory learning, (2) assimilation of new valuable knowledge through transformative learning, and (3) the use of the acquired knowledge to create new knowledge and commercial outputs through learning of exploitation (Lane, Koka and Pathak, 2006).

Organizational absorptive capacity depends on the individual skills and skills, and the ability of the organization to transfer knowledge through clearly defined boundaries and subunits fully identified. A higher level of absorptive capacity makes the most dynamic company dedicated to innovation, as it will be more likely to notice and investigate opportunities presented in the environment (Escribano, Fosfuri and Tribó, 2009).

Zhixiong and Yuanjian (2010), determined that knowledge is the key factor to maintain continuous innovation of enterprises in China. They identified the absorptive capacity as a set of skills and knowledge with which the company has to absorb, transform and use external knowledge. As for the absorptive capacity of knowledge, communication and mutual understanding is crucial, so that the structure of the internal organization, cognitive, cultural barriers and other aspects have great influence.

They defined the process of absorptive capacity of knowledge in four stages: 1) Acquisition, defined as the ability to identify and judge the knowledge, 2) Absorption, which involves understanding and interpretation of knowledge, 3) Transformation, in which effectively integrates knowledge and 4) Utilization stage where new knowledge is developed.

Knowledge, as the absorptive capacity, can be analyzed from two aspects: individuals and organizations, so the absorptive capacity of knowledge within the companies depends on the absorbency of knowledge of people and the mechanism to share this knowledge among staff; They conclude that knowledge, and in a practical manner, the absorptive capacity is key for companies to maintain a competitive advantage through innovation and use of external knowledge (ditto).

Anatoliivna (2013), states that the fundamental assumption behind the concept of absorptive capacity is the ability of a company to use the knowledge that exists outside of it depends on the knowledge that the organization has in its interior, including basic skills, language in common, and also the knowledge available through the latest scientific and/or technological developments in a research area.

Patel et al. (2014), stress that the absorptive capacity plays a role in both increasing and managing changes in innovation performance. They divide the absorptive capacity in two stages: 1) the ability of potential absorption involving the acquisition and assimilation of knowledge, helping companies to acquire external knowledge of customers, competitors and suppliers and assimilate the knowledge acquired to facilitate innovations and 2) the performed absorption capacity which involves transformation and

exploitation of knowledge that help businesses to effectively utilize the opportunities arising from the increasing diversity of knowledge.

They underline that the ability to acquire and synthesize and assimilate external knowledge within the organization, it is essential for dynamic organizations seeking new solutions to meet the latent needs of customers.

Models for measuring the absorptive capacity.

Ying-chun, Shuxian and Qian (2009), divided the Chinese provinces into two groups according to their capacity to absorb technology, then explore whether the technology side effects of inflows of foreign direct investment depends on the absorptive capacity through the analysis of data recorded between 2003 and 2007.

In this research he identified the variables through which the absorptive capacity would be measured: 1) Number of patent applications per province, 2) Number of patents granted per province, 3) Capital stock by foreign investor at the end of a year, 4) spending on R&D per province, and 5) Population with or above college education. These authors conclude that the spillover effect is greater in the group containing the provinces with greater capacity for technology absorption, indicating the importance of this to influence the behavior of the spread of technology.

Chen and Xu (2010), measured the impact of communicating explicit and tacit knowledge within and across organizational boundaries in their absorptive capacity and competitive advantage. With a sample of 286 companies in China, they concluded that both, the potential absorption capacity as well as the performed absorption capacity are able to contribute to the competitive advantage of companies, and that the mechanisms of interpersonal and external communication have a significant effect on the development of this capacity, confirming the importance of personal interactions and inter-organizational when companies want to tap foreign knowledge.

Jimenez, Angelov and Roa (2010), University of New York, analyzed the evolution of the concept of absorptive capacity, operation and measurement. They determined the different measures absorptive capacity: 1) Measures related to R&D in 39.4% including: R&D, system, expenses, investment, among others, I&D + Patents, Patents, R&D + technical and managerial IT knowledge, 2) organizational structure and the design-related measures 11.3% comprehends: communication in the organization, organizational culture, human assets -skills, motivation, performance- and formalization -routines, repetition-, 3) Measures related to network with 11.3% including: suppliers, customers, competitors, universities, alliances, partners customer,, and others, 4) Hybrid measures 38% involving: R&D + Organization, R&D + network, R& D + Organization + Network and Organization + Network.

They also offer an alternative to the predominant focus on the functional and practical research and development in innovation studies.

Roshartini, Takim and Nawawi (2011) propose a model for measuring absorptive capacity in building organizations in Malaysia, indicating that the absorptive capacity is measured by the ability and motivation of employees; to measure their ability they use performance evaluation and training as critical variables which indicate that invest in formation increases human capital, leading to a positive relationship between training and performance of its employees. As for motivation, they emphasize that the practices in human resource management influence individual performance, providing incentives that lead to appropriate behaviors.

Dutse (2013) obtained the absorptive capacity of companies in Nigeria, measured as a percentage of net profits invested in various technological activities such as R&D, design innovation, acquisition of licensed technologies, staff training and activities development and employment skills; This analysis found that the intensity of investment in the development of the absorptive capacity of companies have a significant effect on the innovative capacities of manufacturing companies in Nigeria Turing sector.

Absorptive capacity exists as two subsets, the potential absorptive capacity refers to the acquisition and assimilation of external knowledge, and the performed absorptive capacity which contemplates processing and exploitation of this knowledge (Anatoliivna, 2013). In addition, three concepts are considered within organizations that are related to the absorbency, the first one is learning, then innovation and finally managerial cognition.

The more knowledge an organization has in an area, the greater is its absorptive capacity, providing there is more learning in that area (ditto), also argues that the absorption of knowledge is easier if staff have knowledge in common in terms of experience, training or personal history. On the other hand it is emphasized that only through collaboration with other elements of the exterior, such as competition, suppliers, universities, customers, among others, can create radical innovations, giving a competitive position in the long term environment, for which the organizations install "vigilantes" who absorb, filter and pass environmental information to relevant groups within the organization.

Anatoliivna (2013), emphasizes the importance of cognitive perspective that directors of companies possess to understand the information environment and reduce complexity through mental maps within managerial cognition, this is translated into a logical dominant direction that influences the organizational form, learning processes and indirectly, the level of absorptive capacity.

The model created by Mustafa and Flanagan (2014), for small and medium enterprises in the construction sector in Australian rural areas which want to implement new technologies, evidence is lacking of a mechanism to carry out the process of technology transfer, so they proposed four main components which are strongly linked:

1. External sources of knowledge: recognizing customers, suppliers, manufacturers and research institutes as enablers and as the source of information/knowledge, and technology for construction companies. At the same time he found that critical information for these take up and use new technology includes: costs, advantages and benefits of technology, types of technology available, how to use technology, necessary skills, safety, security aspects, availability, reliability and technology aspects of mobility for the technology can reach to rural areas. In addition he emphasizes that the level of understanding the provided information impacts on the decision whether acquiring and implementing new technology.
2. Factors that influence the absorptive capacity: grouped according to two categories: factors under control to be overcome - communication and sources of new knowledge, organizational policies, culture, labor training, attitude and motivation of the workforce - and those out of control to be overcome - cost and accessibility, infrastructure, availability and supply, demand, government policies - which must be addressed and overcome so that companies can absorb and advance for the technology implementation.
3. Absorptive capacity process: Company skills to obtain, assimilate, transform and exploit new technology in management levels; and the ability of the workforce in place to implement the technology at the stage of production which identifies the communication or the sources of new knowledge, labor training, motivation and attitude as important factors that influence the ability of absorption of the workforce at the implementation stage.
4. Results of the process. It involves the impact of new technology after implementation phase. The model recognizes the possibility that new technology cannot improve or may even reduce company productivity and performance. If this occurs, the company should evaluate the technology and the whole process undertaken. If the technology implementation has a positive impact, it becomes a learned lesson, and can be considered to use in another project and gain a competitive advantage.

After analyzing the field of nanotechnology Iran, Gholizadeh, Bonyadi, and Moini (2015), determined that the absorptive capacity can be measured if it is divided into two major dimensions: 1. Processes and 2. capabilities, which in turn are influenced by their respective critical factors, exploration, change and use as measuring factors within the dimension of the processes

being, and within the capabilities are internal and interaction with the external environment.

Valentim, Verrissimo and Franco (2015), identified and categorized the knowledge management practices that Portuguese SMEs can take to develop their absorptive capacity. The knowledge management practices to assess factors analysis of the absorptive capacity were made through 3 - dimensional and 4 factors.

Dimension 1: knowledge acquisition integrates collection practices knowledge through competitive intelligence and interinstitutional collaboration with suppliers and customers, and is obtained through Factor 1) knowledge of the company based on competition and Factor 2) knowledge of the company based on the value chain.

Dimension 2: knowledge conversion means transferring the organization knowledge at all levels and absorption of knowledge of business partners and people in the organization is evaluated with Factor 3) conversion of knowledge.

Dimension 3: application of knowledge is based on the use of knowledge to solve new problems, develop new products and services, improve efficiency and set the strategic direction of the company; it is calculated with the Factor 4) application of knowledge.

The authors found differences between manufacturing and service sectors. Services are more concerned about the practices of knowledge conversion than manufacturers, and small companies most interested in all dimensions of absorptive capacity than midsized businesses.

One of the latest models is proposed by Hurtado and Gonzalez (2015), in which it is proposed to measure the absorptive capacity in the manufacturing and services sectors in Colombia, using four dimensions: 1) Acquisition: the ability of a company to capture external, specific knowledge through investment in R & D, investment in technology transfer and investment in machinery and equipment; 2) Assimilation: internalization and dissemination of acquired external knowledge, gained from cooperation with suppliers and customers; 3) Transformation: building new routines, leading to the development of new products and / or processes, which is measured considering the number of people involved in innovation activities, education and training they have and the technical support they receive ; 4) Operation: given the ability to acquire, assimilate, disseminate and transform external knowledge, the company must continue the process of applying this knowledge, obtained by observing innovation in production methods, improving the quality of products or services and number of major innovations in the organization.

Despite the investigations carried out so far to understand and promote innovation in SMEs, it remains an open problem since they are efforts that

address separately the same areas of opportunity; in this study these proposals are intended to contribute to the generation of innovation in these economic units, to achieve this it is proposed to measure the absorptive capacity of the companies that are located within the manufacturing sector, through which it contributes to identify your area of opportunity to increase this capacity.

Methodology.

To perform this study, six databases were analyzed: Wiley Online Library, Institute of Electrical and Electronics Engineering (IEEE), Bussines Source Complete (EBSCO HOST), Association for Computing Machine (ACM), SpringerLink and ScienceDirect, acquiring 80 scientific articles on absorptive capacity, of which 41 were those who contributed to this research, including studies in 22 countries highlighting that the main contribution is being made in Asia at least during the last ten years. Also a summary of models and variables identified on the reviewed literature was structured (Table 1).

TABLE 1

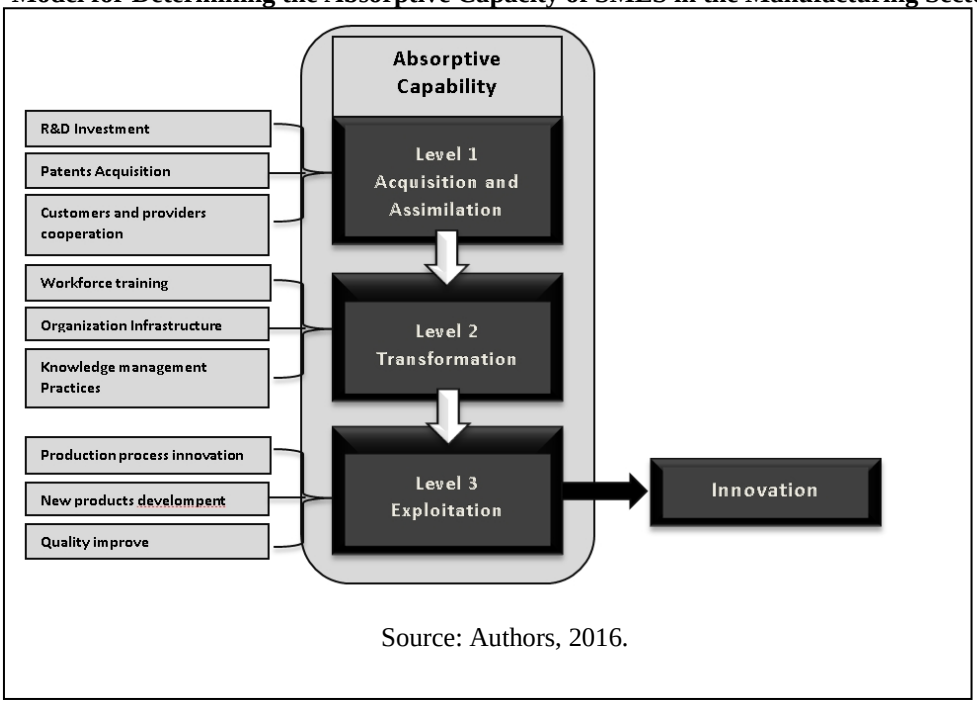
Authors	Components
Ying-chun, Shuxian and Qian, 2009	1) Number of patent applications. 2) Number of patents granted. 3) Capital stock by foreign investor per year. 4) R&D Investment 5) Population with or above college education.
Chen and Xu, 2010	1) Potential absorptive capacity. 2) Absorbency made. (Both permeated by the interpersonal, cross - functional and external communication)
Jiménez, Angelov and Roa, 2010	1) R&D (R&D Investment, Patents and Technical Staff) 2) Organizational Structure (communication and organizational structure). 3) The network (suppliers, customers, competitors and alliances). 4) Hybrid Measures (R & D Organization R & D + Network + D + I + Network Organization).
Roshartini, Takim and Nawawi, 2011	1) Capacity of employees (performance evaluation and training). 2) Employee motivation (Practices HRM)
Dutse, 2013	1) Investment in R & D 2) Exclusive innovation 3) Acquisition of licensed technologies 4) Staff training 5) Activities of employment and development of staff skills.
Anatoliivna, 2013	1) Workforce (experience, training or background) 2) External collaboration (competition, suppliers, universities and customers)
Mustafa and Flanagan, 2014	1) external knowledge sources (customers, suppliers, manufacturers and research institutes) 2) Influencing factors (communication, organizational politics,

	culture and motivation of the workforce) 3) Process (skills of the company and managers to assimilate, transform and exploit new technology) 4) Results (impact)
Gholizadeh, Bonyadi and Moini, 2015	1) Processes (exploration, change, use, maintenance and reorganization of knowledge) 2) Capacities (internal and interaction with the external environment)
Valentim, Verrissimo and Franco, 2015	1) Acquisition (knowledge of the company based on competence and based on the value chain) 2) Conversion (knowledge of partners and their staff) 3) Application (use knowledge to solve problems and develop new products)
Hurtado and González, 2015	1) Acquisition (investment in R & D, technology transfer, machinery and equipment) 2) Assimilation (Cooperation with suppliers and customers) 3) Transformation (new product development, innovation activities, education and staff training) 4) Exploitation (innovation in production methods, improving quality and number of major innovations)

Source: Authors, 2016.

After the analysis, a range of proposals were identified to measure the absorptive capacity; however, no comprehensively model includes dimensions identified as the most important, which is why the following model is proposed:

FIGURE 1
Model for Determining the Absorptive Capacity of SMES in the Manufacturing Sector



Source: Authors, 2016.

According to the proposed model, the absorptive capacity is identified in three levels of maturity, the higher the level, the greater the generation innovation. Each level can be measured by depending on different variables. At the level of acquisition and assimilation are companies that have the ability to capture external knowledge, internalization and dissemination of such knowledge (Lane, Koka and Pathak, 2006) within this stage are considered the variables of investment in R & D representing the proportion of capital allocated an organization in R & D, between total sales; the acquisition of patent refers to the number of implemented from an external development patents; cooperation with suppliers and customers is given depending on the number of suppliers and customers with whom trade relations (Flor, Oltra and Garcia, 2011) remain.

When the organization is at the level of transformation, are able to create new routines that lead to the development of new products and/or processes, here they are considered factors such as staff training which is measured from the academic degrees, but also They are taken into account certifications and work experience, in addition to the training he has received; the variable structure of the organization focuses on communication in the organization, organizational culture, human assets, motivation, and formalization (Jimenez, Angelov and Rao, 2010); in terms of knowledge management practices, it is measured in three dimensions: degree of acquisition, conversion rate and degree of implementation (Valentim, Verissimo and Franco, 2015).

Within the operating level -the highest level- companies in addition to observe all the above variables also apply innovation in production processes are categorized develop new products and make improvements in quality, measured by the number of innovations implemented in their processes, generating goods and number of implemented in improving the differential characteristics of their products/services respectively (Flower, Oltra and Garcia, 2011) innovations.

Conclusion

This research is the first part of a study that aims to contribute to the theory and practice of measuring the absorptive capacity of useful knowledge by business organizations. A literature analysis was performed to identify the international presence in this matter; it could be observed that the eastern countries of the emerging Asian bloc -with the exception of Japan, which is rather a pioneer in particularly- China, Indonesia and Malaysia, are the countries that most contributions have made to this study that seeks to guide companies with the aim of improving their competitiveness in the global environment of highly competitive markets. The focus of all these

contributions from Asia focuses on the absorptive capacity as a tool to increase the innovative capacity in companies. Based on the analysis of these proposed model arises preliminarily, a model that will be more suitable to reality and circumstances of enterprises.

Future work will involve the construction of the measuring instrument based on the variables in Figure No. 1, validating it by taking appropriate criteria studies by Anatoliivna (2013), Dutse (2013), Hurtado, A. Gonzalez, C. (2015) Jimenez, Angelov and Roa (2010), Li and Chen (2010), Roshartini, Takim and Nawawi (2011), Valentim, Verrissimo and Franco (2015) and Ying-chun, Shuxian and Qian (2009); allowing to answer the research question: What is the level of absorptive capacity of SMEs in the manufacturing sector in Mexico?

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