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Research Article

Dependence Study on Technological Capacities of the Transnational Industry and SME in Aerospace Sector

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Abstract

Objective: This study is to determined the dependence of relation factor of technological capacities between the transnational industries and SMEs of the aerospace industry in Baja California, Mexico. **Materials and Method:** The dependent variable was determined by factorial analysis where four dimensions were considered, organizational, innovation, design and manufacturing. **Results:** It was found that SMEs in dimension of manufacturing processes have to comply with the requirement set by the standard QS 9100 and NAPCAP certifications. In design dimension, SMEs have treated to incorporate the design processes to its manufacturing processes however, it is difficult by the high cost of licenses of softwares used in the aerospace industry. In innovation dimension is noted that both types of business are committed with innovation to take advantage of the financial support and have collaboration with educational institutions. Finally, in organizational dimension, SMEs and Transnational have points in common due to both are increasingly focused in recruiting human resource better trained and with higher level of studies. **Conclusion:** Due to its great importance and economic relevancy, local SMEs should form multi-disciplinary clusters to satisfy to the transnational of providers and considering technological capabilities required.

Key words: Aerospace, technological capacities, SMEs, clusters

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

In Mexico, the takeoff of the aerospace sector is recent and there are great perspectives of that in medium term, it built several production centers to develop higher value-added activities. In this regard, there are significant advances in businesses, universities and research centers that under the support of public policies in science and technology are cementing the foundations of what will be the aerospace sector in the country. The formation of national firms linked to Transnational companies of the sector will detonate the development of micro, small and medium enterprises (SMEs) in this sector. This requirement arise the need for strategic projects to achieve high standards in the aerospace industry and promote economic development at national and local levels[1,2].

Dutrenit mentions several concepts of technological capabilities, which was defined at beginning of the eighties by Westphal, Kim and Dahlman as the ability to make effective technological knowledge use which lies not in the knowledge that it has, but the use of the knowledge and the ability to be used in production, investment and innovation[3].

From the very beginning, the concept of technological capacity has referred to two dimensions: A wealth of knowledge and the use of that knowledge. This last dimension organizational-institutional gained importance in the 1990s where Bell and Pavitt refer to technological capabilities as "Domestic capabilities to generate and manage change in the technologies used in the production, these capabilities are widely based on specialized resources[3]".

Recently the concept has evolved to be more openly considered the role of the economic and political environment. In this sense, Kim defines technological capabilities as "The ability to make effective use of technological knowledge to assimilate, use, adapt and change existing technologies. Also, lets you create new technologies and develop new products and processes in response to the changing economic environment".

The companies build technological capabilities through learning processes, as well technological learning refers to the dynamic process of acquisition of technological capabilities. Thus, the companies that learn over time and accumulate technological knowledge may undertake progressively new activities and in this way they are able to acquire new capabilities[3].

Based on the concepts of technological capabilities for the development of this study, it will be defined by the following concept:

"The technological capacity is the set of knowledge and skills that give sustenance to the production process. Covers from the accumulated knowledge, the generation of basic transformations, the complex manufacturing processes, concepts of processing, transformation and recycling of raw materials, until the configuration and performance of the final products as well as the addition for generation of new technologies based on the needs of the changing market".

The literature has focused on firm efforts to face technological changes in different ways. In smaller firms, technological activities are sometimes part time and sometimes given other names like 'Design' and 'Production engineering'.

According with Molina-Domene and Pietrobelli[4] different strands of literature have explored the process of knowledge adaptation and creation at the firm-level. Indeed, alternative ways of measurement are studied suggesting that a deep understanding of firms learning processes and capabilities accumulation is obtained from case studies with the short coming of losing comparative power.

As mentioned by Khayyat and Lee[5], there are three benefits mainly to make technological capabilities based index measure: First, theoretical analysis which enables the researchers to test different innovation theories and their relation as a drive engine to the economic growth. Second, technological capabilities based index as a source of information will enable policy makers to place their countries in a position where strength and weaknesses can be identified. In consequence, appropriate innovation policies may be formulated and finally such indices may act as inputs for firm strategies to enable managers to understand the extent of the technological advance to better develop their innovation activities.

Khayyat and Lee[5] developed a technology capabilities index used information related to the development of science and technology and innovation for developing countries. Besides Hansen and Ockwell[6] contribute to filling this gap, utilizing in-depth qualitative firm-level data to analyze the extent to which the use of different learning mechanisms can explain differences in the accumulation of technological capabilities. The study found that firms relying on a combination of learning from foreign technology partners and internal learning by planned experimentation make most progress in terms of technological capability. Other investigations consider Omar *et al.*[7] that absorptive capacity in Technology Transfer (TT) in construction organizations could occur simultaneously involving the flow of imported technology (i.e., knowledge, skills and tools) via construction projects. The absorptive capacity is the ability of the firm to assimilate imported technology depending on their organizational technological capabilities. The goal of TT is to measure the level of absorptive capacity in the form of knowledge, skills and tools via construction projects to improve local technological capabilities for construction organizations.

Van de Vrande *et al.*[8] reported that SMEs clearly have taken up a more open approach towards innovation. An important part of the survey focused on the motives and challenges of SMEs when pursuing open innovation. Many SMEs believe, it is necessary to use abroad set of methods to meet the ever-changing customer demand and to prevent the firm from being out performed by competitors or new entrants. Motives related to control, focus, costs and capacity.

Studies carried out by Carrasco[9] indicate that Baja California state (Fig. 1) is a strategic point for the aerospace industry also is the state with the greatest number of companies dedicated to this sector. This has led to the incentive to companies SMEs to form a group that promotes the development of their technological capabilities by means of training programs and certifications necessary for this type of industry.

MATERIALS AND METHODS

It was applied a survey to Transnational and MSMEs companies. The applied questionnaire is based on earlier investigations performed to metal-industries and modified for aerospace sector[10]. This questionnaire was divided into four dimensions (Fig. 2).

As the first point, the questionnaire was validated and then applied to some aerospace companies in Mexicali. The validation method used for the questionnaire was the Delphi method which it is a method of finding consensus Hsu and Sandford[11]. Additionally, a group of experts analyzed the questionnaire, contributing with their knowledge and experience for enrichment.

The degree of expertise of the participants answering the questionnaires has a decisive influence on the accuracy and reliability of the criteria that they offer. To achieve a selection of questions that responds to the interests of study, it was necessary to consider the technical qualification of specialists and specific knowledge about the object in study, among other points or items. Figure 3 shows the methodology that followed in this study.

Subsequently to validation and setting of this study, it is proceeded to survey to an equal number of companies in each group: Transnational corporations (large) and SMES (Table 1).

The questions were analyzed 7 for the organizational dimension by defining the way of manging the factory, 5 for the area innovative, 18 in design and 15 in the dimension of manufacturing.

For the statistical analysis as a first step was the approach of the assumptions to check which were identified in the following manner.

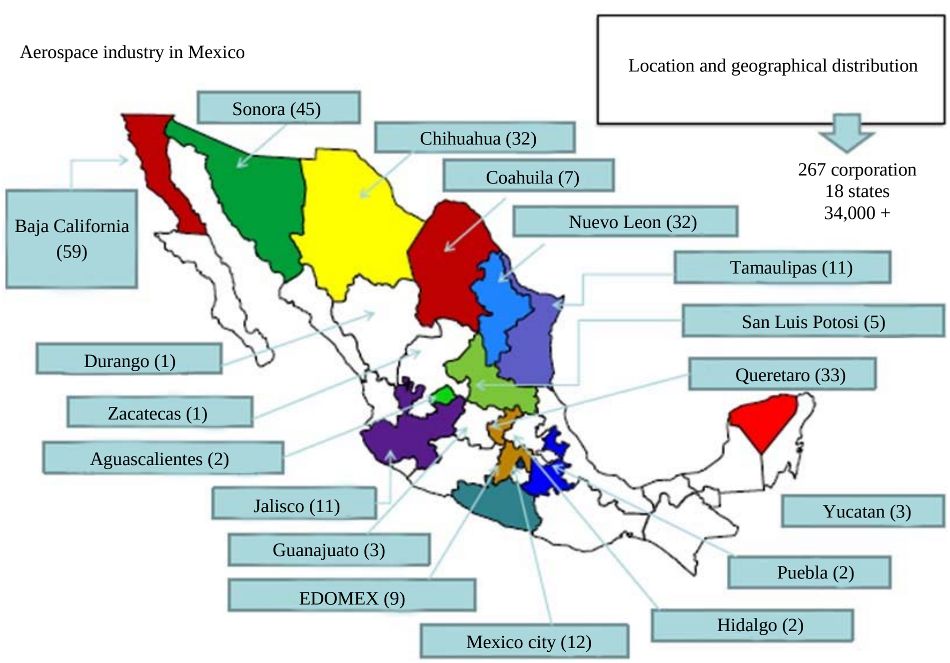

Fig. 1: National distribution of the aerospace industry

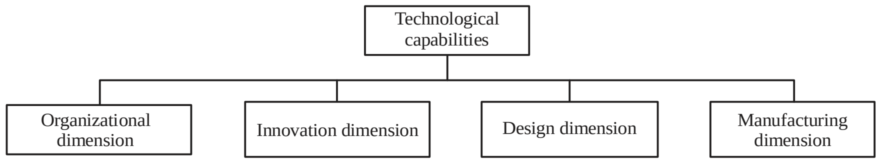

Fig. 2: Classification of technological capabilities in the questionnaire

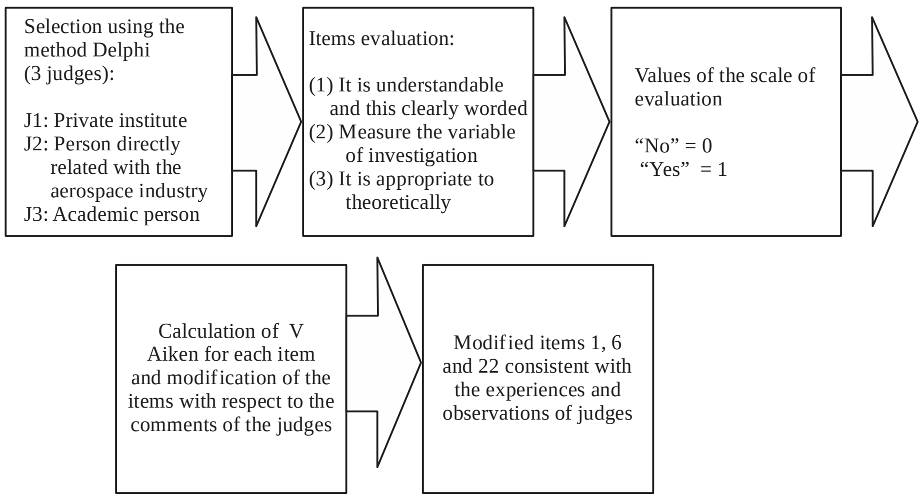

Fig. 3: Methodology for the validation of the survey by way of the criterion of experts

Table 1: Stratification typical enterprise in Mexico (by number of workers)

Size/sector	Industry
Micro	1-10
Small	11-50
Medium	51-250
Larger	251 or more

H0 : Transnational industry and industries SMEs are independent with regard to the technological capacities

H1 : Transnational industry and industries SMEs are dependent with regard to the technological capacities

Using a criterion to a confidence level of 95%, contrasting the results of the χ^2 calculation obtained by the software with the $\chi^2_{1-\alpha}$ (critical value, obtained from tables). On the basis of Pearson's chi-squared test[12], If χ^2 calculation $\leq \chi^2_{1-\alpha}$ then H_0 is rejected.

For this analysis, the data processing was carried out with the information package SPSS version 17.0. To carry out the analysis of the chi-squared Pearson's (χ^2) and determine the unit in each one of the dimensions.

RESULTS AND DISCUSSION

The obtained data from applied surveys were grouped by dimensions (organizational, innovative, design and manufacturing) as it was established previously. The analysis of these results is presented in Table 2-5 according to the statistician χ^2.

It can observe the realized analysis to a question of design dimension (question 29 from Table 4) the design of the products of the company who realizes it? It has one χ^2 (chi-squared) of 0.139 with a gl (grade of freedom) equal to 1, p-value (0.139) = 0.71 compared with $\chi^2_{1-\alpha}$ = 3.84 ($p_{1-\alpha}$ = 0.05) obtained of stage is confirmed by the theory and the H_0 is pushed back, therefore, one concludes that there is coincidence with regard to the industry SMEs and the Transnational corporations.

In the question 59 of manufacture dimension (Table 5), what is type of technology mainly reached in the mechanized area of the company? it has one χ^2 (chi-squared) of 1.875 with a gl (grade of freedom) equal to 1, p-value (1.875) = 0.170904 is compared with p ($\chi^2_{1-\alpha}$) = p (3.84) = 0.05 obtained of stage is confirmed by the theory and the H_0 is pushed back, therefore one concludes that there is coincidence with regard to the industry SMEs and the Transnational industry.

Figure 4 shows that there is a dependence relation between the organizational capabilities, innovative, design and manufacture between SMEs and big industries established in Mexicali agreeing with previous studies in developing countries[4,5].

Table 2: Analysis of organizational dimension

Item	Dimension	Question	Gl	χ^2_{calc}	$\chi^2_{0.05}$	Agreement
P3	Organizational	Your company is incorporated in Mexicali how long ago?	2	5.00 (p = 0.082)	5.991 (p = 0.05)	HI
P4		No. of employees	1	5.00 (p = 0.025)	3.841 (p = 0.05)	Ho
P5		Maximum level of education of employees of the company	3	2.91 (p = 0.406)	7.815 (p = 0.05)	HI

Table 3: Analysis of innovation dimension

Item	Dimension	Question	Gl	χ^2_{calc}	$\chi^2_{0.05}$	Agreement
P14	Innovation	Did your company receive financial support?	1	0.75 (p = 0.386)	3.841 (p = 0.05)	HI
P14a		In which activities did your company receive the financial support?	1	0.75 (p = 0.386)	3.841 (p = 0.05)	HI

Table 4: Analysis of design dimension

Item	Dimension	Question	Gl	χ^2_{calc}	$\chi^2_{0.05}$	Agreement
P23	Design	Which of the following business activities are the responsibilities of your company in the area of design? Enumerate High to Low	2	5.00 (p = 0.082)	5.99 (p = 0.05)	HI
P29		Who are responsible of product design in your company?	1	0.139 (p = 0.709)	3.84 (p = 0.05)	HI

Table 5: Analysis of manufacturing dimension

Item	Dimension	Question	Gl	X^2_{calc}	$X^2_{0.05}$	Agreement
P54	Manufacturing	Which are the different types of software used for the production and design areas in your company?	2	2.22 (p = 0.329)	5.99 (p = 0.05)	HI
P59		Which is the type of technology mainly achieved in the work area of the company?	1	1.88 (p = 0.170)	3.84 (p = 0.05)	HI

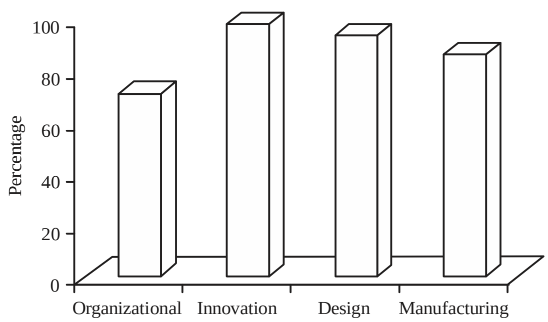

Fig. 4: Percentage of dependency by dimension

Another important factor is to search new markets in the aerospace sector to generate innovation projects for the support and development of the industry in the country. First, to know the technological capabilities of aerospace companies and second, show to SMEs on this same sector these requirements, certifications and capabilities they must accomplish to be provider of services and products and so achieve the development themselves and the region.

With regard to the organizational dimension, the differences between SMEs and Transnational are obvious (the number of employees and total sales). However, they have points in common due to both are increasingly focused in recruiting human resource, better trained and with higher level of studies besides, providing support to their staff to take studies at the technical level, undergraduate and postgraduate levels since, the same sector requires better qualified staff for the development of its products. The competitive priorities of this sector are to provide the best quality of their products and to comply with the requirements of the client and to divide in functional areas to ensure the best management to their organization.

In innovation dimension is noted that both types of business are committed with innovation to take advantage of the financial support and have collaboration with educational institutions either with academic development given to their employees or with the development of projects that help to promote technology in aerospace[1]. Besides, both firms are part of industrial group that can help to promote its development in the region as it is well pointed by Dagnino[13].

With regard to design dimension of Transnational corporations have recently incorporated in their companies design departments. Recruiting engineers that have been trained for this function so they can give support to its manufacturing processes. On the other hand, the industry SMEs have treated to incorporate the design processes to its manufacturing processes however, it has been made difficult by the lack of support and the high cost of licenses of softwares used in the aerospace industry. Besides, subcontracting services for external design is not feasible as the majority of the parts manufactured for the aircraft must carry a strict control of reliability and traceability by rules established quality for this branch in the industry. Some softwares are widely automated, providing a great support for design of part and for manufacturing. Among the software more used in this type of companies are Mastercam, Solidworks, CATIA and ProEngineer. Therefore, the training of staff with advanced knowledge in this type of software is of the most importance to the development of this area in Mexicali.

In the dimension of manufacturing the aerospace industry in most of the firms surveyed are directed to processes of machined. These processes are constantly updated to comply with the requirement set by the standard QS 9100 and NAPCAP certifications. Being this a great limitation for the industry SMEs since, the high cost and strict requirements, most of the times are unachievable for SMEs. Besides, the support provided by the government of the state have been insufficient to achieve these requirements. As consequence, large corporations send their products to perform some processes to the United States or any other country where these processes are certified by the standards of NAPCAP, thus increasing the costs of transfers and increasing the time of delivery of the client to ensure the quality and traceability of their products[1].

The formation of an industrial cluster requires not only the determination of the technological capabilities that would create the chain supplier integration, but clustering must conform in function of a sustainable project in time to pass tier levels 3, 2 and 1 as it well mentioned by Van de Vrande *et al.*[8], Chan and Pretorius[14] and Viana and Cervilla[15].

In addition, it is necessary to establish a program of training, funding for equipment and accreditation in the different agencies in the sector.

CONCLUSION

In this study, it was shown that there is a relationship between technological design and manufacturing capabilities of Transnational industries and SMEs in the aerospace sector. It was found that SMEs have to comply with the requirement set by the standard QS 9100 and NAPCAP certifications. To incorporate the design processes to its manufacturing processes, they have to get licenses of softwares used in the aerospace industry and to commit with innovation for taking advantage of the financial support and have colaboration with educational institutions.

The SME industry required to develop cluster to be added to the chain value of Transnational industries established in Mexicali and contribute to economic development of the state.

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