Research Article
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Determining factors for the competitive integration of Mexican companies in the CVG of the aerospace sector

Abstract

The integration of value chains is important due to the link between the productivity of the national industry and the improvement of the quality of life of the population. Mexican companies have difficulties inserting themselves into the global value chain of the aerospace sector and little is known about the problems for their integration and permanence. A mixed study is proposed through the analysis of international experiences in the integration of companies into the sector, as well as interviews with specialists and agents in public and private institutions, to determine which factors hinder the insertion of Mexican companies in the aerospace industry global.

Keywords: aerospace, Mexican companies, CVG, manufacturing exports

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Introduction

Among the objectives of any country is to create conditions to improve the standard of living of its citizens. The ability to do so depends on the productive activities of the national industry. The dynamism of Mexico's manufacturing exports, achieved in the last decade, was the result of the increase in the production capacities of industries such as automotive, electronics, electrical and aeronautics.[1]

Many of the most important multinational companies in the aerospace sector have settled in Mexico, given the advantages that the country offers. However, the insertion of Mexican companies in the aerospace industry has been scarce and little is known about the productive conditions, technological and digital tools of the Mexican companies that participate in this sector.[2–4]

The viability of globalized production processes has received increased attention following events such as the Covid-19 pandemic, the war between Ukraine and Russia, as well as tensions between China and the United States. These events have highlighted the vulnerabilities of an intertwined global market, and shortages of components and materials have encouraged the creation of strategies to strengthen the security of supply chains.[5]

The race for technological leadership is another factor that impacts production processes on a global scale, since it has led to the emergence of policies aimed at protecting the development of new technologies, nascent industries, the training of skills and talents, as well as the availability of water and energy.[6] The integration of the Internet of Things (IoT), artificial intelligence (AI), robotics, blockchain, cloud computing, 5G/6G network connectivity, virtual and augmented reality in manufacturing processes, they are another important aspect that also impacts production processes. These technologies that integrate the pillars of Industry 4.0 (I4.0) face significant challenges in Latin America due to the lack of incentives for innovation and high costs for the introduction of new technologies.[7–9]

According to Schatan,[10] significant investments will need to be made in infrastructure, including antennas and towers, in addition to telecommunications companies will have to acquire and enable the networks necessary to operate 5G. At the same time, it is necessary to prepare human capital, at all levels from primary school to university so that people become familiar with and can operate these technologies. This transformation process requires investment in high-quality digital infrastructure, as well as fostering strong links between industry and university. Other challenges mentioned by Burgess & Connell[11] are the technological impact on work and the skills that new technologies demand, aspects that cannot be left aside since the automation of tasks implies changes in terms of control, autonomy and require new skills. The shortage of semiconductors, among other factors, has fueled technological competition between China and the United States. Although it has opened opportunities for the integration of Mexican companies into global value chains (GVCs), the semiconductor industry is intensive in human capital, which is why it requires specialized knowledge and skills throughout the supply chain, from research and development (R&D) and manufacturing, to packaging and installation into final products.

The semiconductor industry relies heavily on STEM (Science, Technology, Engineering and Mathematics) graduates with specific skills, particularly in software development and artificial intelligence.[12] These elements highlight the importance of anticipating future needs, skills and new work alternatives. The Covid-19 crisis has made it known that low levels of investment in knowledge result in limited science and technology infrastructure. It showed that for Latin American countries, most of the R&D spending is financed and executed by the public sector, generating poor innovative dynamics among companies and concentrating modernization through imports. It also showed that the technological gap expands every year and some companies compete in international trade with technological problems and a connectivity structure far below that of developed countries.[13] The development of national industry is important in social and economic terms. National companies generate jobs that give workers the purchasing power, thereby encouraging the exchange of goods and services, which in turn boost the production and sales of companies, contributing to national economic growth. The low profitability of national companies has the opposite effect and leads to no or minimal investment in R&D.[14–16] Low productivity is due to structures with limited technologies, related to insufficient investment in innovation. Investment in R&D comes mostly from the government and is allocated to basic research, relegating experimental and applied research, which contribute the most to the industry, creating a loop in which insufficient investment in R&D undermines the ability to create quality jobs.

"Structural heterogeneity", so called due to technological asymmetries and inequality in income distribution, influence the creation of economic activities with high added value and the ability of companies to create jobs. Given that diversification and boosting productivity are related to the size and capabilities of companies, it is necessary to strengthen long-term institutions and policies aimed at industrial development.[14] In Mexico and Latin American countries, 90% of the industry is made up of micro, small and medium-sized companies with efficiency and profitability gaps, incapable of creating quality jobs and boosting productivity.[15] If companies do not have technological capabilities, they have more difficulties adopting new technologies, which is why policies are required to stimulate the construction of technological capabilities in companies. Education policies for the training of human resources with work skills with a technological focus. All these policies connected in a vision of development.[16,17] It is important to identify areas of opportunity to improve the competitive position of Mexican companies in the aerospace industry, especially under the current trend towards the relocation of productive and supply chains promoted by the main economies (China, the United States, the European Union, among others) for security reasons, as well as technological, productive and commercial leadership.

Research problem or object of study

The insertion of Mexican companies in the global value chain (GVC) of the aerospace sector is scarce. There is little information about the characteristics, production conditions, technological and digital tools of the Mexican companies that participate in this sector. Little is known about the problems and difficulties for the integration and permanence of Mexican companies in the CVG of the aerospace industry.

Research questions

Central question: What factors drive the integration of Mexican companies in the CVGs of the aerospace industry?

Subsidiary questions:

Macro level: What is the weight of national and international regulations for the insertion of Mexican companies in the industry? What is the relationship between the international positioning strategies by the main original equipment manufacturers (OEM) and the integration of national suppliers?

Meso level: How do industrial policies impact the insertion of Mexican companies in the sector?

Micro level: How do the productive, technological and financial and innovation characteristics of Mexican companies influence their entry into the aeronautical industry?

General objective

Determine which factors favor the integration of Mexican companies in the global aerospace industry, as well as carry out a reflective investigation and explanation of the trends to determine public and private interventions to strengthen the sector.

Specific objectives

i. Identify and characterize Mexican companies (size, production processes, classification) that have managed to join the aerospace industry value chain.

ii. Identify and characterize the alliances between the agents that make up the Mexican aerospace sector.

iii. Analyze historical and current industrial policies focused on the insertion of Mexican companies in the CVG of the aerospace industry.

iv. Identify the industrial policies used in other countries and compare the results they generated.

v. Identify and analyze the relocation strategies implemented by the main (OEM) in the aerospace sector.

Hypothesis

The adoption of advanced technologies, as well as the development of sociotechnical skills, drive the integration of Mexican companies into the global value chain of the aerospace sector and encourage investment in R&D.

Methodology

Under a mixed approach, primary and secondary data are considered. The Table 1 shows primary data sources that included specialists in the sector, enterprises public organisms and academy for the application of interviews. The Table 2 shows the databases that were proposed for query how secondary data sources.

Table 1 Primary data sources

Industry	Approximately 368 companies	
Public organisms	Ministry of Economy	Surveys and/or semi-structured interviews
	Economic Development Secretariats of different states	
	Mexican Space Agency	
Academy	41 higher education institutions/research canters	
	Mexican Council of Aerospace Education (COMEA)	
Specialists	United States-Mexico Foundation for Science (FUMEC)	
	Mexican Federation of the Aerospace Industry (FEMIA)	
	Presidents and directors of clusters	

Primary data with the purpose of analyzing the characteristics, tools and conditions of Mexican companies to identify factors that hinder their insertion into the sector. Through interviews with specialists and agents in public and private institutions linked to the industry in Mexico, it is possible to triangulate and compare the information.

Secondary data with the purpose of analyzing international experiences in the integration of companies into the aerospace sector. It is possible to determine frequencies and correlations between the factors by studying the experiences of the insertion of the aerospace industry in other countries that have integrated into the aerospace industry.

Expected results

The results obtained from the quantitative and qualitative analysis will allow us to account for the current problems of the industry

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in a context of international and national crisis. The possibility of interviewing directors of clusters in the sector will explain the meso and micro problems. There is the possibility of identifying and explaining through different theoretical approaches the technological, productive and technical capabilities obstacles that affect creating new dilemmas in industrial and technological policies. The results may contribute to expanding research on the sector and drawing conclusions about the development of innovation at a business and regional level, as well as detecting social actors capable of putting the results obtained into practice.

Table 2 Secondary data sources

DENUE-INEGI Available at: https://www.inegi.org.mx/app/mapa/denue/default.aspx	It offers identification, location, economic activity and size data of more than 5 million active economic units in the national territory. The information available in this database will allow information to be obtained from some of the companies that make up the aerospace sector in Mexico.
TIVA (Trade in Value Added) of the (OECD) Available at: https://www.oecd.org/sti/ind/measuring-trade-in-value-added.htm	Provides information on GVC participation through backward and forward linkages for the years 1995 to 2018 in 66 countries. It is possible to analyse how other countries participate in the industry according to the internal value added in exports and final demand of the partners. It is possible to analyse the positions and experiences of other countries in the aerospace sector to compare the results of the strategies implemented by country.
Eora MRIO (Full Eora) Available at: https://worldmrio.com/	It is a global supply database (basic prices, trade margin, transport margin, taxes and subsidies) that documents inter-sector transfers between 15,909 sectors in 190 countries a complete time series for 1990-2021. Aerospace supply chain data can be analysed, compared and related by country to identify trends.

Empirical analysis

Attendance at three events: Mexico's Aerospace Summit 2022 in Querétaro, the Industrial Transformation Mexico 2022 in León Guanajuato and the Mexico Aerospace Fair (FAMEX) 2023 in the State of Mexico; It allowed us to identify different agents of the Mexican aerospace industry and led to a first approach with the agents in order to conduct interviews. In this first immersion, contact information was obtained from the presidents of clusters, companies, public servants, universities, research centers, among others. Simultaneously, it began with monitoring on social networks such as LinkedIn, Twitter and Facebook, to contact and participate in webinars organized by different agents related to the sector, with the aim of observing the context and obtaining a greater number of prospects and contacts.

In this first immersion, four types of semi-structured questionnaires were designed that were used as a guide for the interviews. One type of questionnaire was aimed at businessmen, another at public agency employees, one at directors of educational institutions, and another at cluster presidents and sector experts. Additionally, a Google Forms form was designed, made up mostly of multiple-choice questions and statements with a Likert scale. A first version of the survey was administered during Mexico's Aerospace Summit and the Industrial Transformation Mexico. In May 2023, the survey was sent by email to the 101 members of FEMIA and the 93 partners of the Baja California aerospace cluster. From October 2022 to June 2023, 34 responses have been registered.

Using an empirical approach, theoretical concepts about the relevance of advanced technologies in production processes and vocational training, as well as the link between R&D investment and business productivity, are related to empirical data. Through this approach, information was obtained on the alliances between the agents that make up the aerospace sector in Mexico, the strategies for the training of professionals in educational institutions, considering the changes generated by I4.0 and the capabilities of companies in the sector.

The empirical material consists of 26 interviews collected between October 2022 and May 2023. The industry experts interviewed include representatives of industry associations, research institutions, university presidents, company CEOs, and public servants from government ministries (a detailed list of empirical material is provided in Table A1 in the Appendix). The expert selection criteria were established following the concept of homogeneous sampling, defined by Sampieri et al.,[18] as a sample where profiles are chosen that are considered representative of a segment of the population or a community (not in a statistical sense, but in a prototype sense). In addition, interviews were conducted with presidents of recently created clusters, as well as managers of companies in the process of integration, which do not yet have contracts in the sector.

Table A1 Summary of agents interviewed

Actor		Industry years	Interview date
1	aCP	30	5/11/2023
2	aES	2	5/12/2023
3	aFV	21	11/8/2022
4	aGV	16	5/30/2023
5	aUM	10	5/10/2023
6	bAC	4	5/19/2023
7	bAW	6	5/16/2023
8	bCP	8	5/12/2023
9	bdr	0	4/26/2023
10	bMA	15	11/15/2022
11	bML	15	11/21/2022
12	bMM	0	5/23/2023
13	bPA	14	5/24/2023
14	bSM	3	5/24/2023
15	bZS	10	5/23/2023
16	cIDA	10	5/30/2023
17	eAC	32	10/17/2022
18	eAV	15	11/25/2022
19	eCC	20	2/1/2022
20	eEG	16	1/27/2023
21	eEM	20	10/18/2022
22	eME	12	11/11/2022
23	eTS	15	9/26/2022
24	gCO	-	11/18/2022
25	nAP	1	5/19/2023
26	nME	1	5/18/2023

The following labeling system was used to cite interviews: Each group of interviewees has an abbreviation (a= academic institutions, e= experts representing business associations, b= companies, c= research centers, n= new representatives of business associations). companies, g= government public servants. Each interviewee was assigned a lowercase character (a, b, c, . . .) at the beginning of the ID.

The semi-structured interviews covered three topics: the effects caused by the pandemic in the aerospace sector, the technological structure and the training of human resources for the implementation of I4.0 in the sector, as well as the forms of linkage between agents. The precise focus was adjusted according to the group of interviewees: while the questions were focused on industrial level and broader trends in interviews with experts, the interviews with entrepreneurs were focused on the details of the integration of I4.0 in production processes. In the case of academics, the interviews were focused on training programs without losing sight of the I4.0 approach and for public servants the interviews were directed towards policies to promote the sector.

Interview data were analyzed using a theory-oriented coding method, and an analytical method for synthesis of findings.[19] The empirical analysis relates the theoretical concepts of the relationship between labor productivity, investment in R&D and the capabilities of companies, as well as the industry 4.0 approach. As a synthesis of interviews conducted with experts in the aerospace sector in Mexico, as well as a review of the literature on the four aforementioned dimensions, Table 3 provides an overview of the dimensions and analytical categories.

Table 3 Analytical dimensions and categories

Dimensions	Categories
Productive aspects	Characteristics of companies in the sector
	Integration of Mexican companies into the sector
Technological aspects	Processes where I4.0 is used
	Infrastructure
	Skills and knowledge of workers
Technical capabilities	Training programs in educational institutions
	Infrastructure in educational institutions
Linking between agents	Certifications
	Academia, industry and government

Table 4 Companies with activities related to the aerospace sector in Mexico

State	FEMIA	DENUE	Cluster Partners
Baja California	97	36	93
Queretaro	fifty	twenty	60
Sonora	58	3. 4	-
Chihuahua	52	26	-
New Lion	33	3	-
Coahuila	14	2	-
CDMX	13	1	-
Tamaulipas	12	-	Recent creation
Jalisco	10	-	-
Edo. Mex.	10	3	12
Guanajuato	5	2	12
Durango	3	2	-
Zacatecas	2	2	-
San Luis Potosi	2	2	-
Yucatan	2	1	-
Puebla	2	1	-
Hot Waters	1	-	-
Oaxaca	1	-	-
Gentleman	1	-	-
Total	368	135	

Source: Own elaboration with information obtained in interviews and in the National Statistical Directory of Economic Units (DENUE), consulted on August 25, 2022, available at: https://www.inegi.org.mx/app/mapa/denue / default.aspx

Empirical analysis results

Productive aspects: characterization of Mexican companies that have managed to enter the aerospace sector

The aerospace sector in Mexico continues to evolve, given that companies that carry out activities in the aerospace sector also have activities in other sectors such as automotive, electrical, among others, the number of companies shown in table 4 is approximate. The Mexican Federation of the Aerospace Industry (FEMIA) considers around 65% of companies with capital of foreign origin and 35% of Mexican origin. However, it is important to note that in states located on the border with the United States it is common for companies to have mixed capital, which includes a percentage of foreign capital. The recently created clusters in Guanajuato, State of Mexico and Tamaulipas do not yet have contracts in the aerospace sector and particularly the clusters of Guanajuato and the State of Mexico together group 24 companies with exclusively Mexican capital. Therefore, the percentage of companies with Mexican capital is less than 35%.

According to Casalet[20] and Villavicencio et al.,[21] suppliers can be classified as direct when they produce airplane parts and indirect when they produce everything that does not go on the airplane. In the work carried out by the authors, they identified only one Mexican company "Indumet" with direct activities. Currently, it has been possible to identify four more Mexican companies "Jaiter", "Mimsa", "Hyrsa" and "Frisa" that carry out direct activities. In the Querétaro aerocluster, 25 SMEs with Mexican capital are identified, one of them with patents for dry seals for gas turbines and a start-up graduated from UNAQ that recycles carbon fiber "Rhem composites."

Mexican companies in the aerospace sector, mostly SMEs, carry out indirect consulting activities, offer advisory services, industrial mechanics and automation services, resource management services, information technology services, design solutions and driven engineering. by simulation, software and robotics, among others. Activities with a high technological content and that require constant investment in R&D, as well as updating the specific competencies and skills of the personnel who provide the services. Mexican companies in the aerospace sector focus on indirect activities, receive very mature processes of lower complexity and take a long time to generate purchase orders. Denoting the influence of technological asymmetries on high value-added economic activities referred to by Bárcena & Cimoli.[14]

Considering that the global standard of investment in aeronautical R&D is around 10% and when Mexican companies invest in R&D they do so at a scale of 2%, investment in innovation influences productivity as mentioned by Mazzucato.[15] Hence, the Mexican companies that have managed to integrate into the aerospace sector are consolidated companies in one or several markets, that have productive capacities, machinery, financial stability and the certifications required by clients in the aerospace sector and that, although to a lesser extent scale, they invest in R&D. Different informants mentioned that it is common for companies in the automotive sector to try to migrate to the aerospace sector. In the first decade of the 2000s, support programs were designed and implemented to certify SMEs in Querétaro to promote their development and insertion into the aerospace sector.[20] Following up on these programs, different informants commented that of the approximately 30 companies that participated in the support programs, currently only 5 companies managed to integrate into the sector.

The lack of motivation in the integration of companies that migrate from the automotive sector is related to the high percentages of investment required and that the return is usually slower, compared to the continuous flows of other industries such as the automotive sector. These initiatives leave learnings so that in the development of future programs, in addition to the characteristics of the aerospace sector, the organizational structure and the development of capabilities of companies in the long term, the particular characteristics of the aerospace sector and information on the times in which product life cycles in the sector.

Technological aspects: infrastructure and processes where I4.0 is used

In the aerospace sector, IoT is a requirement demanded by purchasing companies to observe the behavior of each of the suppliers' machines and guarantee the traceability of the processes. Mexican companies with activities in the sector have included IoT in their processes either to improve service to their customers or to optimize their own processes. 5G network connectivity, as well as cloud computing, are technologies widely used by companies that make up the sector, connection speed and/or latency have not influenced production processes or communication between national and international suppliers due to that MNEs have their own communication programs and have their suppliers and customers well identified.

Artificial intelligence, blockchain and the use of robots in other industries have been used to automate processes and predict times and trajectories in the mass manufacturing of parts such as in the automotive sector. However, in the aerospace sector the manufacturing of aeroparts is not massive; the certifications for the manufacturing of parts and structures are very specific to guarantee the safety of the components. Therefore, the use of robots or artificial intelligence in the manufacturing processes of aeroparts entails multiple tests and validations, mainly before the certifying authorities of the processes, as well as with leading companies in the sector.

Given that Mexican companies are focused on indirect activities or aeroparts manufacturing activities, primarily using mature technologies, the use of robots and artificial intelligence has not been a priority. This is due to the requirements in the certifications themselves, as well as the investment amounts in machinery that represent a challenge for Mexican companies.

The use of virtual and augmented reality, as well as digital twins in the aerospace industry, is frequent in training processes, aircraft testing, simulations and aircraft design. The Mexican companies that participate in this type of services are companies where the founders and staff have extensive knowledge in software development. Data analytics has also not been widely used; however, some interviewees perceive it as a technology that could be useful in predicting parts delivery times and plant issues that impact supply chains. The implementation of I4.0 in the aerospace sector is heterogeneous, companies with greater capital, which tend to be multinational companies or with mixed capital, have more advanced manufacturing processes and allocate a greater percentage to R&D to test new technologies. Mexican companies in the sector are implementing them in accordance with the demands and specifications of their clients and, to the extent of their capabilities, they are coping with the adoption of the new technologies that they demand.

Relations between institutions: national and international organizations

Product and process certifications continue to be an important element for the integration of Mexican companies into the aerospace sector. When foreign companies establish operations in Mexico, they implement certified processes and products in their country of origin. To obtain contracts, Mexican companies must have the certifications required by their clients. These certifications are carried out before foreign institutions or organizations where their clients have their processes certified. For mixed capital companies, the process is usually more agile because foreign partners take their products to be certified in their countries of origin. Mexican capital companies regularly turn to certification agencies to begin the preparation and certification process, most of the time without knowing what certifications they need and that these depend on the clients' country of origin.

There are cases of Mexican companies that were created for the aerospace sector and their development is linked to the training, skills and knowledge of collaborators and workers. A representative example is "Horizontec", dedicated to the manufacture of parts and aircraft for the training of pilots in flight schools. This company began in 2014 with the manufacture of a small sports airplane with the "Halcón 1" project carried out through links with research centers such as the National Center for Aeronautical Technologies (CENTA) in conjunction with SME companies, other research centers in Aguascalientes and universities.

Although the company is an example that the link between agents favors the development of projects that involve cutting-edge technologies and advanced composite materials, it is important to mention that the company four years ago began the certification process before the Federal Aviation Agency. Civil (AFAC) and is still in process. Unlike international companies, Horizontec is not subject to international certifications since its target market is the Mexican market. And international companies are not subject to certification before the AFAC, since they have certified processes in their country of origin and most of the manufacturing is exported.

According to several informants, the difficulties that Horizontec has encountered are the shortage of raw materials such as aluminum, since Mexico is an intensive importer of this material. Hence, one of the company's objectives was to investigate new materials. Another important challenge is market trust, since it is a Mexican company, prospective customers have a preference for aircraft with quality certifications granted by international institutions.

Since they depend on AFAC certification, the guarantee of the safety of the aircraft influences its marketing. Various informants mentioned that the AFAC is developing the regulations for the certification of aircraft manufacturing in Mexico, since before projects such as the "Halcón 1 and 2" the regulations and the urgency to recover category 1 in aviation safety has focused AFAC's activities on this process.

The case of Horizontec shows the importance of relationships between institutions and the weight that certifications have in the aerospace sector. The production of an aircraft in Mexico was possible through the participation of research centers, universities and companies. It highlights the training and knowledge necessary in the performance of the participants' collaborators and workers, as well as research for the development of materials. However, it also highlights the necessary participation of other agents such as the AFAC.

Technical capabilities: Skills and knowledge of workers

The relocation process of companies in the aerospace sector in Mexico has involved the creation of training programs aimed at the needs of specialized personnel in the sector. The relocation of companies had its beginnings in Mexico around 45 years ago in the states of Chihuahua, Sonora and Baja California. These states currently have technological universities involved in aeronautical technical training. More recently, after the arrival of Bombardier to Querétaro, UNAQ was founded approximately 15 years ago, focused on aeronautical training.

In August 2022, through the participation of educational authorities, directors, professors and researchers from different public and private educational institutions in Mexico, they carried out the first Strategic Agenda of Higher Education Institutions (IES) for the Aeronautical and Space Sectors 2030.[22] The development of the agenda involved the participation of public and private agents focused on improving educational opportunities in the aerospace sector in Mexico. This initiative can be seen as part of the industrial strategy, as it focuses on increasing the skills necessary for the sector.

For the strategic agenda, they carried out an analysis of 31 higher education institutions and research centers with educational offerings aimed at the aerospace sector. The informants mentioned that the institution best evaluated in terms of infrastructure, technological resources, laboratories and with the greatest educational offer oriented to the aerospace sector was the UNAQ.

It should be noted that the UNAQ equipment includes technological contributions and practice laboratories from the private sector, as well as public resources. The case of the UNAQ in Querétaro confirms that the joint investment of the public and private sectors increases the construction of technological and innovation infrastructures and the increase in educational opportunities as mentioned by Mazzucato.[15]

Taking the case of the Querétaro aerocluster as an example, the development of the aerospace sector in the state was faster compared to states such as Baja California and Chihuahua, highlighting the investment in capacity building that drives industrial development. However, training programs and efforts in the aerospace sector have been efforts of state governments and still face significant challenges in developing competencies and skills in the field. Educational institutions do not have the facilities, materials and tools for the development of practices, so the link between agents is essential to promote the development of capabilities.

In the analysis carried out for the Strategic Agenda of the IES 2030 (SE, 2022a), it was estimated that 86% of the academic training oriented to the sector is at the engineering and bachelor's level, 12.4% are university technicians and 1.6% for doctorates. The demand for personnel is related to the manufacturing activities carried out in the Mexican aerospace industry. The document states that by 2030 there will be no needs for postgraduate levels and 34% more graduates from the higher technical university (TSU) level will be required.

The document highlights the need to promote investment in R&D in HEIs, as well as the need for teacher training in postgraduate degrees in aeronautics and aerospace, despite the fact that an increase in demand for TSU and not postgraduate degrees is expected. Considering that value-added activities are related to the ability of companies to create better-paid jobs, it seems contradictory that for an industry as specialized as the aerospace sector there will be no demand for postgraduate training.

Aspects to take into account to deepen the investigation

The study carried out for the strategic agenda of the IES foresees a trend for the industry to continue being manufacturing and the geolocation of added value in highly competitive places that differentiate them such as Asia or Europe. Considering these trends, questions arise about how capacity building can be oriented towards innovation and development of higher value-added processes, without leaving aside the manufacturing that is currently carried out and in which an increase in job creation is expected.

The investment capabilities of Mexican companies in the implementation of I4.0 are limited to their productive capacities. International clients with greater technological capabilities invest and implement processes with greater added value. Given that technological capabilities influence the participation of Mexican companies in the sector, it is also worth considering how technological capabilities could be developed in Mexican companies. Mexican companies that have managed to integrate into the aerospace sector have done so through specialized knowledge in the sector and invest, although on a smaller scale, in R&D. It is useful to identify how and which actors can drive specialization and investment in R&D.

Considering that there were national and state public policies for the development of the sector, monitoring the results would allow identifying which contributed to the development of productive capacities of the national industry or to the insertion of Mexican companies in the aerospace sector.

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None.

Conflicts of interest

The authors declare that there is no conflict of interest.

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