Evaluation of Strategies for Aeronautical Value Chains and the Implications to the State of Ceará, Brazil

Henrique Halisson Evangelista Gomes[1,*], Donizeti de Andrade[1], Lígia Maria Soto Urbina[1], Hugo Santana de Figueirêdo Junior[2]

1.Departamento de Ciência e Tecnologia Aeroespacial – Instituto Tecnológico de Aeronáutica – Divisão de Engenharia Aeronáutica – São José dos Campos/SP, Brazil. 2.Universidade Federal do Ceará – Faculdade de Economia, Administração, Atuária e Contabilidade – Fortaleza/CE, Brazil.

*Correspondence author: henriquehalissongomes@gmail.com

ABSTRACT

Several regions of the world seek to participate in the aeronautical value chain, aiming at employment quality and absorption of technologies. This upgrading movement is studied in industries usually employing concepts and methodologies developed for companies or isolated agglomerations. However, no comparative studies of aeronautical chains' strategies in emerging countries have been identified. This paper evaluates strategies adopted by segments of the aeronautical value chain and, complementarily, presents the implications for the Brazilian state of Ceará. To achieve this objective, the Value Chain Structure-Conduct-Performance (SCP) framework, recently developed for evaluating value chain strategies is applied, by means of a qualitative comparative analysis of segments located in selected territories outside Europe and the United States. Celebration of international agreements and improvements in infrastructure are identified as structural elements of influence in the determination of strategies aimed at creating jobs in the chain. The aeronautical value chain in the state of Ceará has an attractive structure to services. The study also suggests that the use of Value Chain SCP framework can contribute to the analysis of technology-intensive value chains and, more specifically, provide recommendations on strategies for segments of the aeronautical value chain located in emerging countries.

Keywords: Aeronautical value chain; Industrial policy; Strategies evaluation.

INTRODUCTION

The attraction of segments of value chains of high technological intensity is one of the most desired modalities of insertion in global chains by territories, in the search to offer local jobs with higher remuneration (Corrêa 2017). Global value chains also represent an opportunity for the insertion of emerging economies by means of their comparative advantages reinforced with territorial industrial policies (Cafaggi *et al.* 2012).

For Milberg and Winkler (2013), this phenomenon called upgrading represents the movement along the value chain with a view to capturing greater added value and raising the standards of specialization governed by comparative advantages. Four types of upgrading were originally identified: product, process, functional, and interchain (Humphrey and Schmitz 2011): a) product: moving towards more sophisticated products with higher unit value; b) process: achieving a more efficient transformation

Submitted: Jul 08, 2022 | **Accepted:** Oct 11, 2022
Peer Review History: Single-Blind Peer Review.
Section editor: Eric Nioya

of inputs into products through the reorganization of activities or the introduction of new technologies; c) functional: acquiring new functions (or abandoning old ones) that increase the skill content of activities; d) interchain (or intersectorial): applying skills acquired in a function of a chain in a different sector/chain.

To successfully insert a certain territory in a technology-intensive value chains, Etzkowitz and Leydesdorff (1995) highlighted in their triple helix framework the importance of government policies for technology transfer between academia and industry.

Understanding how a value chain segment settles in a certain territory is relevant (Alcacer and Delgado 2016). In fact, the interest in the development and incorporation of models referring to strategies adopted by companies and territories is documented in Porter's industry forces analysis, in the Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis, in the Diamond model and in the territorial Structure-Conduct-Performance (SCP) framework (Figueirêdo Junior and Abreu 2009).

In the Diamond model presented by Porter (1998, 2000), the competitiveness of territories is explored in detail but the regular comparison and interaction among competitors are missing. Besides, the model does not consider the performance objectives a certain territory should aim for, and the dynamic impact of relevant spatial interventions (Figueirêdo Junior and Abreu 2009).

Similarly, the SWOT analysis provides a flexible and coherent discussion, with early planning phases. However, its flexibility ends up limiting its use: the lack of priority in the problems or solutions, and the high quantity of information and ideas make its categorization difficult and reveals the ambiguity of its elements (Febrian *et al*. 2017; TCU 2010).

In this context, the Value Chain SCP framework emerges as an alternative for developing, evaluating and comparing value chain strategies (Figueirêdo Junior *et al*. 2014). However, the application of the Value Chain SCP framework has so far only occurred in the context of agricultural commodities (Figueirêdo Junior *et al*. 2016; Muzareba and Khondkar 2021; Yitayih *et al*. 2021), thus leaving a gap in its applicability for value chains of high technological intensity.

An example of a value chain with high technological intensity is aeronautics. In this chain, few countries have the property and capabilities to produce aeronautical technologies, products and services, and the group of producing companies is limited. There are many barriers to entry and returns cannot always be seen in the short term (McGuire 2014). Emerging countries, such as Brazil, make less technological efforts than developed countries, with emphasis on sectors classified as high technological intensity (Furtado and Carvalho 2005).

In Brazil, the main production center of the aeronautical industry is São José dos Campos, in the state of São Paulo. The state of Ceará, in turn, is a major supplier of students to the Technological Institute of Aeronautics (ITA), the main educational institution in the national aeronautical industry, being responsible for occupying about 40% of the available places for students in the academic year of 2018 (Ceará… 2017). It is intriguing to recognize that, even so, Ceará does not have any stage of aeronautical manufacturing in its territory, what would represent a comparative advantage for the region which shows a lack of employment opportunities.

In this sense, Ceará undertook efforts to create an impact on the environment of this value chain, bringing to its territory the first professional master's level course of the ITA outside its base (Professional Master in Aviation Safety and Continued Airworthiness, MP-Safety), in partnership with the Federal University of Ceará, with more than 60 graduates. This effort came as part of a package of incentives to attract airline hubs (Varela 2018), including tax breaks for airlines, the concession of the largest local airport to the international private sector, and the provision of new runways and regional airports in the countryside (Ministério dos Transportes, Portos e Aviação Civil 2018).

However, studies that compare the strategies of aeronautical value chains in territories of emerging countries, such as Ceará in Brazil, and the efforts of those territories, are not available. Thus, the following question arises: what are the strategies adopted by aeronautical value chains in certain territories and the implications for the state of Ceará?

From the justifications for the research and the proposal of the guiding question of the work, the main objective is to evaluate the strategies adopted by segments of aeronautical value chains in selected territories using the Value Chain SCP framework and, complementarily, to present the implications for Ceará, seeking to carry out an upgrading along the aeronautical value chain.

Thus, the following specific objectives arise: (i) to investigate the indicators of SCP for the locations selected in the analysis; (ii) to identify the strategies of the winning value chain segments in selected territories; (iii) to propose strategies for the insertion of Ceará in the aeronautical value chain.

Evaluation of Strategies for Value Chains

In recent history, there has been a perspective that market forces and private entrepreneurship are the drivers of public policies, with governments having only the role of strategically coordinating and guaranteeing macroeconomic stability (Rodrik 2004).

Historically, industrial policies prove to be more effective when endowed with a close relationship between industries, banks and governments. Common interests and values, however, are necessary but not sufficient for an effective industrial policy (Williams 2010).

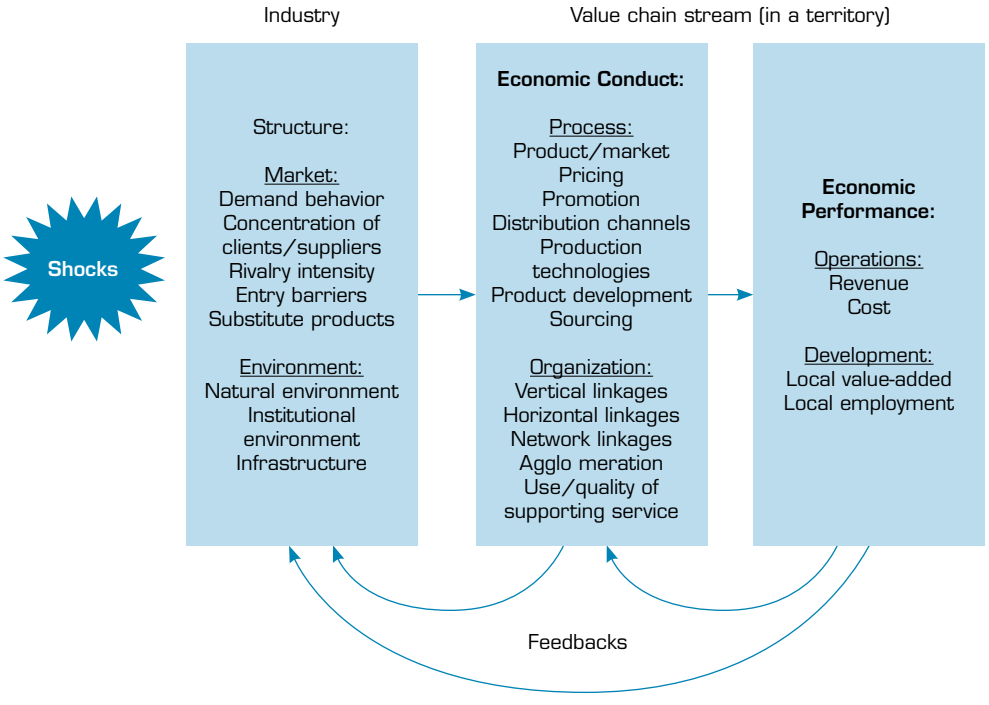
In this sense, it is necessary to observe the distinction between pro-market and pro-business policies, an alignment similar to the contrast between market-oriented policies and structural policies (Farla 2015). Accordingly, it is worthy highlighting the repercussions of implementing a vertical industrial policy, in which a specific sector or company is promoted, based on subsidies or on other state actions (Lazzarini 2015). It is also worth mentioning the context of the full approximation of countries given the reduction in logistical barriers in conflict with their needs to maintain their individual competitiveness.

From the perspective of achieving success, strategists establish a mix of strategies that reflects conditions already in place and that favor organizational objectives (Mintzberg *et al.* 1998).

The existing literature on strategy, innovation and organizations has identified several processes and routines that can be recognized as providing microfoundations for dynamic capabilities, such as research and development teams, new product development routines, quality control routines, technology or knowledge transfer routines, a context inherent to segments of high technology-intensive value chains (Teece *et al.* 1999).

The aeronautical value chain worldwide has had, with greater or lesser emphasis, the participation of government, for the economic development impact it can provide (Caliari and Ferreira 2022; Corrêa 2017; Francelino *et al.* 2019). The spillover effect, for instance, may start with national defense, and be followed by technology dissemination to manufacturing companies and research facilities in general (Lima *et al.* 2005).

In search for a more integrated view of strategy conception, considering chain efficiency and developmental objectives, the Value Chain SCP framework was proposed (Figueirêdo Junior *et al.* 2014). It is an extension of the traditional SCP framework (Bain 1959; Bresnahan 1989), adapted for the design and evaluation of strategies for value chains, more specifically for a segment of a value chain in a territory. This framework considers that the performance of a given value chain stream is a consequence of the strategies adopted by its representatives, which in turn are influenced by the existing structure under which the stream operates, as shown in Fig. 1. In that regard, a value chain stream is the segment of the chain in a territory. The framework has a dynamic nature, in the sense that the elements of SCP are susceptible to changes arising from possible shocks or feedbacks.



Source: Adapted from Figueirêdo Junior *et al.* (2014).

Figure 1. Framework Value Chain SCP and its categories.

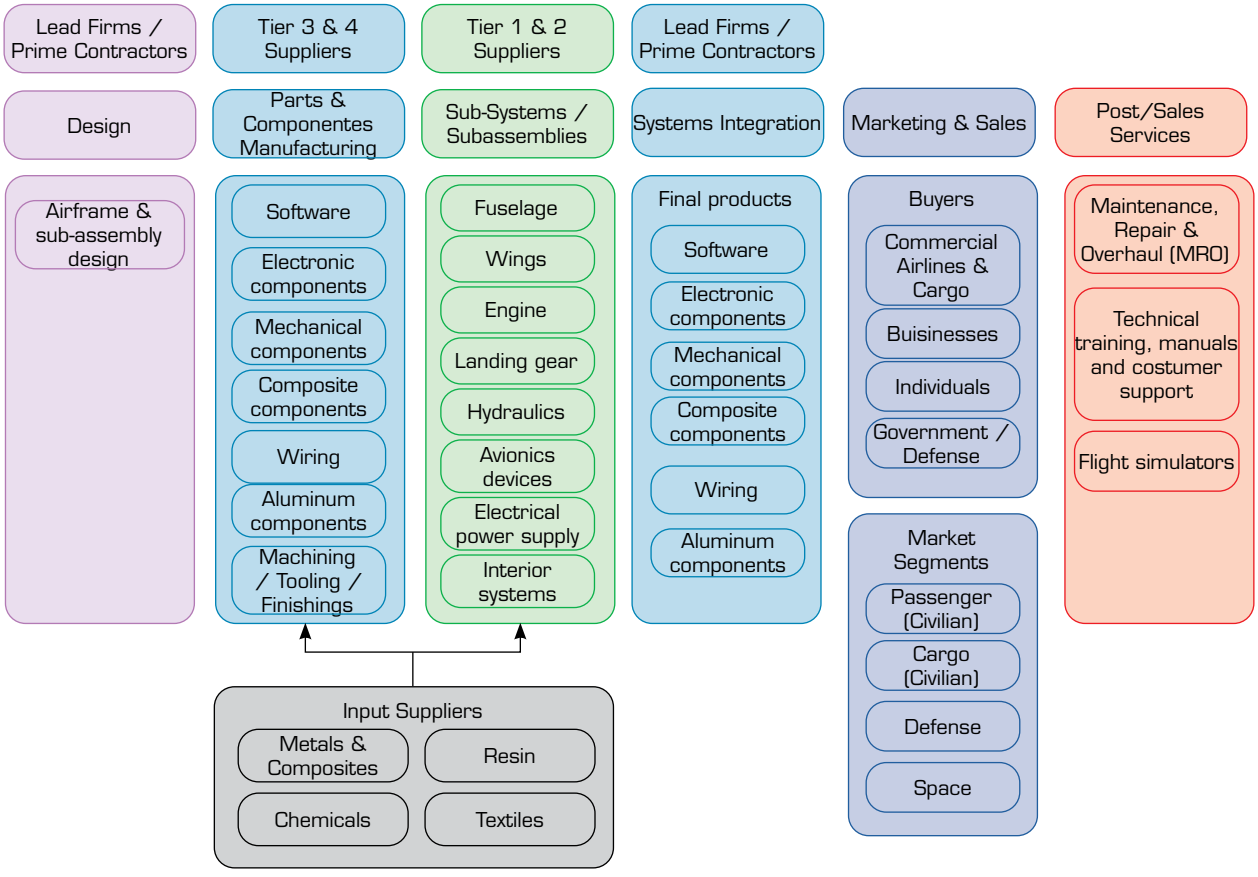
The Aeronautical Value Chain

The aeronautical value chain is characterized by having high entry barriers. It is a productive organization that, while housing its manufacturing to different locations, allows emerging countries to enter segments of lower added value (Bamber and Gereffi 2013). Such entry barriers are not limited to those of a technological nature, but obstacles regarding a high level of regulation, customer support and sales costs, barriers with reputation and political influence in the purchaser's decision. This last characteristic of the sector has justified the intensive support of governments to the sector when there is a clear interest in entering the aeronautical value chain (McGuire 2014).

According to a study by the McKinsey Institute (2012), about 90% of the aeronautical production plants are in Europe and North America and that, in the production of avionics, the five largest companies account for 85% of the market, all with European or American flags.

Global value chains have become much more than an explanatory concept for industrial organizations, but also a key reference for policy design. The focus on foreign direct investment policies targeting a single organization has been slowly replaced by a supply chain approach where strategic considerations, considering a network of contractual and non-contractual relationships of leading companies, are considered in government policies of emerging countries (Cafaggi *et al.* 2012).

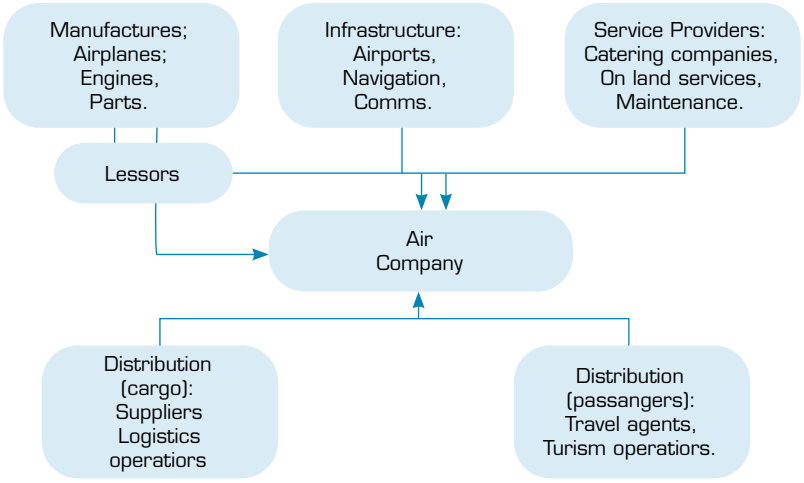
Figure 2 presents the scope of the aeronautical value chain. Although this scope consists of a consolidated view and a broader understanding of the aeronautical sector, different angles of vision regarding the value chain should be highlighted.



Source: Adapted from Bamber and Gereffi (2013).

Figure 2. Aeronautical value chain.

On the other hand, airlines can be understood as the center of the value chain, as suggested by Tretheway and Markhvida (2014) (Fig. 3). The study shows that the segment's profitability is considerably low, with airlines, however, having the lowest levels of profitability. Besides, while the level of vertical integration is limited, the members of the value chain have a sensitive connection in the creation of standards in production and operation, with a consequent reduction in production costs and improvement in products/services with customers. The same study also reveals the scarcity of works that present a more comprehensive assessment of the aviation value chain.



Source: Adapted from Tretheway and Markhvida (2014).

Figure 3. Aeronautical value chain with airlines leading the way.

Waving to the low profitability of airline companies when compared to other productive sectors, Doganis (2009) presents, however, a change in scenarios in the sector with increasing liberalization in terms of production and operation. If, on the one hand, the barriers to entry are significant, the so-called *deregulation* of the airline industry has presented opportunities for aeronautical companies.

METHODOLOGY

This research has a qualitative approach. As for the purposes, it is an exploratory approach to data and information. As for the means, the research uses documental and bibliographic tools (Vergara 1997). By means of a multicase study in which each segment of the aeronautical value chain in a certain selected territory is a case, we seek to interpret the strategies adopted by such segments according to the elements of the Value Chain SCP framework (Yin 2015).

This work highlights the analysis of previous research and, in the same way, the understanding of the agents' actions and the logic to which they were submitted (Godoi and Balsini 2006). Based on this highlight, the use of the value chain scope from Bamber and Gereffi (2013) combined with that of Tretheway and Markhvida (2014) is presented.

Selection of Streams: Segments of Value Chains in Territories

Given the perspective of inserting territories in the aeronautical value chain, taking into account Ceará as a candidate to enter this value chain, the selection of streams initially considered segments of chains in countries outside the traditional producers of the Europe–United States axis, since. According to a study by McKinsey (2012), about 90% of the production plants of aeronautical manufacturing are in Europe and North America.

The lack of studies on the aeronautical value chains in territories outside the Europe-United States axis reveals an opportunity to broaden the discussion of barriers and difficulties that are similar to those encountered by all chains in places that aim to be inserted in more sophisticated segments of the aeronautical value chain.

The choice of a chain in a specific territory within a country has been also allowed. This strategy considers that a chain in the state of Ceará, inserted in a national context, has its own characteristics and interests and, therefore, finding a similar case would allow relevant analogies. Thus, the segments of the aeronautical chain in the territories selected are those located in the state of Querétaro, in Mexico, Singapore, Costa Rica, South Africa, and the state of São Paulo, in Brazil.

Data Selection and Collection

The generic model suggests in its scope a series of indicators inserted according to each element of the Value Chain SCP framework. For its use, indicators must be chosen such that, when standardized, they support comparison and meet criteria such as: a) relevance; b) measurability; c) mutual exclusivity; d) availability of data (Figueirêdo Junior *et al*. 2014).

Initially, seeking to identify the categories of a business environment present in value chains of the aeronautical industry, an exploratory documentary research is carried out in relation to value chains of the aeronautical sector, and from these elements, the indicators of the structure are outlined, present in the Value Chain SCP framework, which scope is preceded by the research by Figueirêdo Junior *et al*. (2014; 2016). In this same topic, the shocks and their impacts on the behavior of the aeronautical value chain are presented, as well as the resilience of this sector presented in the literature (Njegovan 2006; Oxley and Jain 2018).

Having as object the same territories analyzed in the first stage, the search for describing the business strategies aimed at segments of the aeronautical value chain and based on the structure present in these territories follows. Such adopted strategies make up the conduct of the Value Chain SCP framework. Subsequently, the Performance indicators for the segments of the value chains are listed. Considering one of the main interests of the value chain segment in the state of Ceará, which is a candidate for upgrading, emphasis is given to the relationship of employees in the value chain in relation to the population universe of the territory. Finally, the winning strategies of the analyzed segments are identified and then, the implications for the segment of the aeronautical value chain in the state of Ceará, relating them to some initiatives adopted locally.

Table 1 presents the sentences used for data collection in the selected repositories. Exploratory research is used in the Capes, EBSCO, Google Scholar and Google repositories databases. Portals in Portuguese, Spanish and English were searched.

Table 1. Sentences used in research repositories.

Topic	Sentences used in the search
Value chain	"aeronautical value chain", "aircraft value chain", "aerospace value chain"
Selection of indicators (by chain in territory)	"aeronautical industry" + region, "aerospace industry" + region, "aircraft industry" + region, "aerospace industry" + region

Source: Elaborated by the authors.

In the search, specific information that demanded, in turn, similarly specific sentences, are also used and having confirmed the characteristics of relevance, measurability, mutual exclusivity and data availability, the information has been included in the research and presented throughout the work.

Selection of Indicators in the Value Chain SCP Framework

From the previous analysis of information collected in the first phase of the research, indicators were chosen for each element of the SCP Value Chain framework according to the criteria used for the selection of data.

The period of analysis of the indicators and data for the selected territories covers the years from 2012 to 2016. The same period (5 years) is also considered for the implementation of the proposals present in the work, as well as the nonexistence of relevant impact shocks in this period. The general list of indicators for this research follows in Table 2. In this sense, it is worth mentioning that the use of the framework depends on adaptations in the collection of indicators and data for the evaluation of strategies.

Table 2. Preliminary indicators for analyzing the aeronautical value chain strategies by element of the Value Chain SCP framework.

Value Chain SCP Model Element	Category	Indicator
Structure	Institutional environment	Effect of taxes on incentives to invest
		Establishment of international agreements
		Human resources and labor market
		Universities or research institutes focused on the aeronautical value chain
	Infrastructure	Airport infrastructure
		Road and port infrastructure
		Hub for airlines
	Demand behavior	Expected growth rates in the aircraft fleet
		Expected growth rates in demand for workshops
		Aircraft sales (2015 and 2016)
	Customer concentration	Concentration of the five largest importing countries (2012 to 2016)
	Intensity of rivalry	Concentration of the five largest exporting countries (2012 to 2016)
	Entry barriers	Technology and knowledge intensity
		Capital requirement
	Substitute products	Existence of substitute products
Conduct	Products	Presence in stages of the value chain
	Marketplace	Market extension
	Promotion	Event promotion
	Product/service development (R&D)	Origin of Research and Development services
	Network links	Institutions that effect the network of segment participants
	Agglomeration	Agglomeration level
	Quality of support services	Efforts to certify companies in the territory
Performance	Local jobs	Number of employees in the sector
		Ratio of employees in the segment of the value chain by population

Source: Elaborated by the authors.

RESULTS

Selection of Indicators: Structure

As suggested by the Value Chain SCP framework, the structure includes indicators that suggest market behavior and environmental characteristics, the second phase of the research. For the aviation market, market components cross borders, causing customers and suppliers to compete in the same segment. Natural elements become secondary, with institutional and business environment

factors gaining prominence. Based on the information found in the literature, the indicators presented in Table 3 are adopted as indicators. Other data corresponding to information that do not present relevance of differentiation between the territories were disregarded for this analysis.

Table 3. Data from the indicators selected for the Structure in the Value Chain SCP framework.

Category	Indicator	Mexico (Querétaro)	Singapore	Costa Rica	Brazil (São Paulo)	South Africa
Institutional environment	Effect of taxes on incentives to invest[1,2]	3.4	5.9	3.0	1.8	4.0
	Establishment of international agreements	Limited agreements; Development of plans for local development / standardization	Limited agreements; Development of plans for local development / standardization	-	Limited agreements; Development of plans for local development / standardization	Limited international agreements
	Human resources and labor market[1,]	4.6	5.6	4.9	4.3	4.6
	Universities or research institutes focused on the aeronautical value chain	Universidad Aeronáutica en Querétaro (UNAQ), Laboratorio de Pruebas y Tecnologias Aeronáuticas (LABTA)	National University of Singapore (NUS)	No[3]	Technological Institute of Aeronautics (ITA)	National Aerospace Centre (NAC) at University of the Witwatersrand (WITS)[4]
Infrastructure	Airport infrastructure[1]	3.7	5.3	3.2	3.7	3.4
	Road and port infrastructure[1]	3.2	6.3	2.6	2.4	3.4
	Hub for airlines	No	Yes	No	Yes	No

[1] World Economic Forum (2017). Indicators consider secondary data presented at the World Economic Forum 2017, carried out through the Executive Opinion Survey and cataloged in scores ranging from 1 to 7, where 1 is the lowest rating and 7 the top of the respective item; [2] Level of taxes with a horizontal nature; [3] Procomer is the existing body; however, its operations are distant from the aerospace sector; [4] The initiative is considered located in the Centurion Aerospace Village, although agglomeration is not a characteristic of the sector in South Africa, whose nature is focused on Defense. Source: Elaborated by the authors.

Starting the analysis by the Institutional Environment element, the indicator Effect of taxes on the incentives to invest configures a differential element for the entrepreneurial initiative. Since it is a quantitative indicator whose nuance carries the perception of investors, it is, therefore, relevant information for the decision to invest, in addition to encompassing in the indicator, the perception of different support activities. In this regard, the territory of Singapore has been outstanding, receiving an evaluation of 5.9.

Still in the sphere of the Institutional Environment, the Establishment of International Agreements presents, based on information present in the repositories, the presence of agreements celebrated by the territories aiming at business with other countries and that allow entrepreneurs to standardize production and efforts to certify companies present in the territory. Costa Rica is the territory with a negative highlight, in addition to South Africa, which does not have international agreements that highlight the segment.

For this work, it is considered that the shocks do not have a significant impact on the Structure in the period of analysis, nor their influence on the Structure that determines the proposals of conducts for the value chain in Ceará. Although an environment without major changes in Structure is assumed, changes in the indicators over time in a given chain will likely have repercussions. In Querétaro, for instance, there are positive expectations regarding the evolution of the labor quality (Iacovone *et al.* 2021).

Selection of Strategies: Conduct

The listed strategies consist of those of notorious relevance within the aeronautical context (Table 4), the third phase of the research. At this point, it is worth emphasizing that the strategies presented in a certain segment of the aeronautical value chain do not encompass the industrial policies adopted by governments. Such initiatives have the characteristic of impacting structural elements and, consequently, determining the conduct of the segments of the chain.

Table 4. Strategies selected for Conduct in the Value Chain SCP framework.

Category	Indicator	Mexico (Querétaro)	Singapore	Costa Rica	Brazil (São Paulo)	South Africa
Products[1]	Presence in stages of the value chain	Leading Companies (Systems Integration), Leading Companies (Design), Stage 1 (Propulsion systems) MRO	Stage 1 (Propulsion Systems, Aviation Systems) MRO	Stage 2 (Computer Systems, Avionics) MRO[2]	Leading Companies, Stages 1 to 4 MRO	Leading Companies (Military aircraft and missiles) MRO[3]
Marketplace	Market extension	Diversified	Focused	Focused	Diversified	Focused
Promotion	Event promotion	International events (worldwide reach)	International events (worldwide reach)	-	International events (worldwide reach)	International events (continental reach)
Product/ service development (R&D)	Origin of Research and Development services	Stages of greater technological intensity (bigger part outside)	Stages of greater technological intensity (bigger part inside)	Bigger part outside	Bigger part outside	Stages of greater technological intensity (bigger part outside)
Network links	Institutions that effect the network of segment participants	Federación Mexicana de la Industria Aeroespacial (FEMIA), Aerocluster Querétaro; ProMexico	Association of Aerospace Industries Singapore (AAIS); Economic Development Board (EDB) Singapore e Singapore Institute of Aerospace Engineers (SIAE)	Costa Rica Aerospace cluster	Technologic Park São José dos Campos and Local Productive Arrangement (APL) Aerospace and Defense	Aerospace, Maritime and Defense Industries Association of South Africa (AMD), Commercial Aviation Association of South Africa (CAASA), Commercial Aviation Manufacturing Association of South Africa (CAMASA); Department of Trade, Industry and Competition (DTIC)
Agglomeration	Agglomeration level	High agglomeration	High agglomeration	Reduced agglomeration	High agglomeration	Reduced agglomeration
Quality of support services	Efforts to certify companies in the territory	Integrated efforts to certify companies	Integrated efforts to certify companies	-	Companies with a relevant level of certification	-

[1] Classification by Bamber and Gereffi (2013); [2] Procomer (2017); [3] Ambasciata d'Italia Pretoria (2017).
MRO: Maintenance, repair, and overhaul. Source: Elaborated by the authors.

The selection of strategies represents a kind of identity that the segments of value chains in territories adopted for their insertion in the global aeronautical value chain, divided into process and organization groups, according to the Value Chain SCP framework. By having the characteristic of an identity of that stream, it is important not to neglect the list of strategies adopted by a value chain.

In the Products category, production groups are used according to the scope of the value chain in Fig. 2 and listed in the indicator Presence in segments of the value chain. In the measurement of support services, the indicator "Efforts to certify companies" shows those that the value chain undertook so that its products and services are accepted in their context. It is worth mentioning that certification is a basic condition for making products or services available to the market. The segments of the aeronautical value chain in Querétaro and in Singapore stand out for their conduct and investments that favor the certification of entrepreneurial initiatives. The segment of the aeronautical value chain in São Paulo, on the other hand, has considerable maturity in this regard, although certification costs are crucial for entrepreneurs with less investment power. Information relating to the price categories and distribution channels is not possible to tabulate given the universe of products and services from the value chain.

Selection of Indicators: Performance

By means of performance indicators, the fourth phase of the research, it is possible to evaluate the success of a given strategy. It should be noted that the very nature of the aeronautical activity makes it difficult for the final product to be an element of comparison, given that the final product varies from remotely manned aircraft to the so-called wide-bodies, large aircraft.

The nature of the jobs generated also comprises a *sui generis* nature. As it is a highly technologically intensive activity, a good part of the workforce used is made up of personnel with high levels of training and certification needs for their use in the market.

The creation of jobs is a sensitive element in the definition of public policies by managers. This element reveals the performance of strategies aligned with a plan that adheres to local and national aspirations. Thus, the relevance of presenting the number of jobs is considered as one of the factors to be considered for measuring Performance. From the information collected in the official repositories, the data for the indicator chosen for the Performance follow (Table 5).

Table 5. Data from the indicators selected for Performance in the Value Chain SCP framework.

Category	Indicator	Mexico (Querétaro)	Singapore	Costa Rica	Brazil (São Paulo)	South Africa
Local jobs	Number of employees in the segment	8,500[1] (2016)	21,000[2] (2017)	1,000[3] (2018)	23,000[4] (2016)	15,000[5] (2018)
	Ratio of employees in the value chain segment by inhabitants (× 1000)	4.25	3.74	0.20	0.51	0.26

[1] Sector aeronáutico... (2018); [2] EDB (2018); [3] Bamber and Gereffi (2013); [4] Arranjos... (2018); [5] DTIC (2018). Source: Elaborated by the authors.

The scarcity of information and the impossibility of standardizing the data also proved to be contributing factors for the non-use of other variables commonly used for Performance, namely sales or added value.

Based on the relationship of employees in the value chain by the universe of inhabitants of the territory, the segments of the aeronautical value chain in the territories of Querétaro (in Mexico) and Singapore are considered as those that presented outstanding performances. São Paulo and Singapore are the highlights in absolute numbers.

For the segment of the aeronautical value chain in South Africa, the number of jobs presented encompasses a universe that goes beyond aircraft manufacturing plants. It is a national intention for the development of defense.

As for the segment of the aeronautical value chain in Costa Rica, the predominance of initiatives aimed at the production of avionics that, although dense in technology, do not imply in a significant number of jobs, is observed.

Strategies of Value Chain Segments in the Winning Territories

Based on the analysis of the elements of the Value Chain SCP framework, the winning segments of the aeronautical value chain in the territories and the strategies adopted by them are identified (Table 6), the fifth phase of the research. The focus on a certain segment of the value chain, when treated in a sector of high technological intensity, ends up detaching itself from a connotation of low added value. This is what can be observed in the analysis of the strategies of the segment of the aeronautical value chain in Singapore. Strongly shifted to the MRO area, this specialization has given the territory a highly developed characteristic.

In addition to the initiatives to gain visibility for the country as a maintenance hub for aircraft of different sizes and manufacturers, the alignment of strategies with infrastructure improvements, as well as industrial policy initiatives of a horizontal nature, should be highlighted: Singapore is recognized as a one of the great drivers of education and technology.

Another way that impacts the value chain is the improvement in support services, which translates, in the cases, to the need for recognition before the organizations and entities that regulate the sector. The certification's demands by industries that intend to enter segments of the value chain is a mandatory condition, for which governmental strategies are required to be very flexible and to follow the needs that each entrepreneur will have. This strategy is common to both territories (Table 6).

It is worth mentioning that, in those territories where efforts were made aimed at constituting a segment of the value chain in the aeronautical sector, the public power undertook in its industrial policies resources that comprised a significant improvement in the infrastructure that involves the sector's production and with a planning aligned with the actors, establishing clear objectives for the chain.

Table 6. Strategies of the winning segments of the aeronautical value chain.

Territory	Probable Winning Strategies	Probable Contributing Structure Elements
Mexico (Querétaro)	Presence of leading manufacturing and MRO companies; Promotion in worldwide events; Research carried out externally (in the stages of greater technological intensity); Network links involving industry actors; High agglomeration; Support services that guarantee certification efforts.	International agreements aimed at the development of the sector, standardization of processes.
Singapore	Focus on the MRO stage; Promotion in worldwide events; Research carried out internally (in the stages of greater technological intensity); Network links involving industry actors; High agglomeration; Support services that guarantee certification efforts.	Favorable effect of taxes for investments; International agreements aimed at the development of the sector, standardization of processes; Airport infrastructure; Human and labor resources; Hub for airlines.
Brazil (São Paulo)	Presence of Leading Manufacturing and MRO Companies; Promotion in worldwide events; Research carried out internally (in the stages of greater technological intensity); Network links involving industry actors; High agglomeration; Companies with a relevant level of certification.	International agreements aimed at the development of the sector; Universities or research institutes focused on the aeronautical value chain; Hub for airlines.

MRO: Maintenance, repair, and overhaul. Source: Elaborated by the authors.

DISCUSSION

Implications for Ceará

Based on the analysis of the elements of the Value Chain SCP framework, data from the indicators selected for the Structure in the State of Ceará are identified for the period analyzed, from 2012 to 2016 (Table 7), the sixth phase of the research.

The Structure indicators incorporated in this research treat the Brazilian territory as a single soil, and, therefore, present identical absolute values for the territory of Ceará and São Paulo. However, the need for data calibration is evidenced by possible distinctions in the business environment and infrastructure for the two territories. This need becomes latent for the indicators "Airport infrastructure," "Road and port infrastructure," and "Human and labor market resources."

The indicator "Effect of taxes on incentives to invest," however, can bring beneficial differentiation to the northeastern state, since the incidence of state and municipal taxes exerts a lot of influence on the final price. In this sense, Ceará has been presenting advantages for airlines, impacting on the attraction of investments, notably in the increase of air routes.

Furthermore, it is worth mentioning that São Paulo concentrates a large part of the national industry, its clusters and investors, for example, while Ceará traditionally adds value to the service sector.

An important differential in terms of infrastructure resides in the proximity to the northern hemisphere, making the segments linked to services that require displacement exert preference for the State of Ceará, *ceteris paribus*. In line with the implementation of large equipment for the reception of events, the hotel network and several national and international routes, specialization in value-added services deserves attention, such as, for example, the development and availability of flight simulators or large workshops.

Table 7. Data from the indicators selected for the Structure in the Value Chain SCP framework for the segment of the aeronautical value chain in Ceará.

Category	Indicator	Brazil (Ceará)
Institutional environment	Effect of taxes on incentives to invest	1.8[1]
	Establishment of international agreements	International agreements; Development of plans for local development / standardization
Infrastructure	Airport infrastructure	3.7[1]
	Road and port infrastructure	2.4[1]
	Human resources and labor market	4.3[1]
	Hub for airlines	Yes (maturing)
	Universities or research institutes focused on the aeronautical value chain	Technological Institute of Aeronautics (ITA) (temporary) and Federal University of Ceará (incipient)

[1] World Economic Forum (2017).

Ceará has sought to develop its airport infrastructure, notably from the concession of its main airport, in addition to initiatives that make it possible to place its aerodrome as a hub for large companies. Additionally, the master's course coming from ITA as a trainer of specialized human resources also extends the territory to generate products and technologies locally.

Table 8 presents the strategies identified by the Conduct element for the segment of the aeronautical value chain in Ceará. For the category "Products," the indicator "Presence in Segments of the value chain" in Ceará does not have manufacturing stages in its territory. Its outstanding initiative is the LATAM executive aviation workshop installed at Aracati Airport. The market extension can be placed as focused on the services stage, given the limitation of the universe made available by the analyzed segment.

Table 8. Strategies identified for Conduct in the Value Chain SCP framework for the aeronautical value chain segment in Ceará.

Category	Indicator	Brazil (Ceará)
Products	Presence at stages of the value chain	MRO
Marketplace	Market extension	Focused
Promotion	Event promotion	International events (worldwide reach)
Product/service development (R&D)	Origin of Research and Development services	Most part external
Network links	Institutions that effect the network of segment participants	No network links observed
Agglomeration	Agglomeration level	High agglomeration
Quality of support services	Efforts to certify companies in the territory	Support services that guarantee certification efforts are not observed

MRO: Maintenance, repair, and overhaul. Source: Elaborated by the authors.

Regarding the ability to promote the state as a destination for manufacturing initiatives, events held locally only favor airline services. The attraction, promotion and repetition of high-impact events, a possibility that is accentuated with the increasing improvement of Structure requirements, constitutes a strategy with a view to the visibility of a territory for insertion in the chain.

In this item, Ceará hosted the ICAO World Aviation Forum 2018, an impacting event which theme was the *Promotion of Investments for Aviation Development* (ICAO 2018). The hosting of the event represents an initiative that exposes the territory as an investment destination, in addition to promoting the support services and intentions of the government and the State to the aviation community. Those kinds of events generate jobs and familiarize local workers with aeronautical business standards, thus improving the opportunities to diversify towards denser in technology activities.

Links between the segments of the chain present in the state of Ceará are not observed in the territory, or, when observed, were not aiming at developing a value chain segment in the region. To mitigate the absence of network links in Ceará, an alternative would be aligning strategies with the segment in São Paulo.

The "Agglomeration level" is raised only by the scarcity of actions in the value chain in the territory. Aside from any isolated initiatives to produce technologies for the sector, there are no efforts towards certification. This situation could possibly be modified with cooperative strategies with the aeronautical chain segment in São Paulo.

Based on the analysis of the winning value chain segments, Table 9 briefly presents those strategies adopted by the aeronautical value chain segment in the territory of Querétaro and the possible adherence to the strategies observed by the aeronautical value chain segment in Ceará. It should be ratified, however, that such inference of past strategy and applied to the future is valid under the premise that the past structure is maintained and that, therefore, there are no shocks or feedbacks that modify the Structure, thus maintaining this structure for the future.

Table 9. Strategies of the winning segments (Querétaro) of the aeronautical value chain and the presence of these strategies in Ceará territory.

Territory	Probable Winning Strategies	Presence of these strategies in Ceará territory
Mexico (Querétaro)	Presence of Leading Manufacturing and MRO Companies; Promotion in worldwide events; Research carried out externally (in the higher technological intensity bands); Links involving industry actors; High agglomeration; Support services that guarantee certification efforts.	Not observed; MRO still incipient (LATAM executive aviation workshop); Promotion in worldwide events; Research carried out externally (in the higher technological intensity bands); Links are not observed; No agglomeration is observed; There are not support services that guarantee certification efforts.

MRO: Maintenance, repair, and overhaul. Source: Elaborated by the authors.

In turn, the winning strategies present in the territory of Singapore are presented in Table 10, in which those strategies present in the territory of Ceará are also pointed out.

Table 10. Strategies of the winning segments (Singapore) of the aeronautical value chain and the presence of these strategies in Ceará territory.

Territory	Probable Winning Strategies	Presence of these strategies in Ceará territory
Singapore	Focus on the MRO stage; Promotion in worldwide events; Research carried out internally (in the stages of greater technological intensity); Links involving industry actors; High agglomeration; Support services that guarantee certification efforts.	Presence of the MRO stage; Promotion in worldwide events; Research carried out externally (in the stages of greater technological intensity); Links are observed; No agglomeration is observed; There are not support services that guarantee certification efforts.

MRO: Maintenance, repair, and overhaul. Source: Elaborated by the authors.

Such initiatives place the value chain segment in Ceará in a universe aligned with services, resembling the strategies adopted with those present in Singapore. This capability is illustrated by the installation of a base for maintenance of executive aircraft at Aracati Airport. In this sense, the actions adopted by the region require a shift to manufacturing, including to give visibility to the region as a destination for foreign investments, in addition to improving infrastructure elements.

The installation of large manufacturing equipment in Ceará, however, would require changes in the business environment that would require actions linked to the federal plan, including the celebration of international agreements or initiatives that provide for the execution of these agreements.

The intentions, however, need alignment across levels of government and long-term understanding. Such initiatives constitute policies to be adopted.

At the municipal level, incentives would focus on actions of a horizontal nature, such as improving transport routes etc. The most vertical action would reside in encouraging entrepreneurship and training for professionalization in the support service

stages of the aeronautical value chain, from trade at airport terminals, to even expanding the offer of courses for flight attendants. Such measures could arise from agreements with entities linked to learning. Although they are only support services, they are actions that change the ambience and contrast with inertia or isolated actions.

Under the state jurisdiction, the concrete implementation of the Ceará State Air Plan (PAECE) and the diffusion of the culture of regional flights among the municipalities in the interior emerge as impact strategies. In addition, creating the atmosphere for events with an international impact generates repercussion and visibility for investors who shift their intentions to manufacturing.

It is worthy to be noted that many strategies presented are already adopted in different territories. Ceará is not the first territory to attract a hub of large companies (a fact that took place in mid-2017 and 2018). Nor is it the first territory to carry out research in the aeronautical sector. The differential of the winning aeronautical value chain segments in certain territories lies in adopting the aforementioned strategies in line with the service stage and with clear objectives for the development of the local structure of the value chain.

CONCLUSION

The work presented the background that evidences the possibilities of using the Value Chain SCP framework for value chains of high technological intensity, which has been confirmed with the empirical application of the construct for segments of the aeronautical value chain in the selected territories. As implications for the state of Ceará, a subsidiary objective of this research, international agreements emerge as important infrastructure elements for the development of a favorable environment and the attraction of high-intensity leading companies, although this element contributes to the fact that much of the research is carried out outside the territory. Improvements in airport infrastructure and the presence of hubs are essential for the development of service-related segments.

The winning strategies were identified for each territory that presented the best performance according to the framework.

The territories of Singapore and Querétaro (Mexico) are those where the ratio of the number of jobs in the sector to the population of the territory is more advantageous, and the segment of the value chain in each territory adopts different strategies.

While the similarity in issues, such as the promotion of world-wide events, high agglomeration and support services that guarantee efforts towards certification, are observed, the value chain segment in Singapore distances itself from the value chain segment in Querétaro by focusing on the of MRO stage. Querétaro, despite not neglecting this stage and hosting workshops of large companies, has advanced with the leading companies in stages 1 and 2 of the scope of the value chain used for this work.

The main strategies adopted by the aeronautical value chain segment in the state of Ceará for upgrading the value chain and achieving objectives for the territory to leverage jobs were also described. In this topic, the initiatives already underway to absorb the first ITA master's course outside its headquarters are highlighted, in addition to the concession to the private sector of its main airport and the consequent improvement of the structure.

As a proposal for the segment of the value chain in Ceará, given the structure with strong adherence to activities related to services, similar to the segment of the value chain in the territory of Singapore, it is suggested that actions be orchestrated in this sense. In addition to this strategy, the need to work on supporting activities that favor the certification of any entrepreneurial activities in the chain should be highlighted. Tangent with the strategies of the value chain, it is evident the need for deliberate actions of industrial policies aimed at impacting the institutional environment with strategies at the municipal, state and federal levels, notably the latter that would provide International Agreements that represent an important condition for success of segments of aeronautical value chains.

Finally, the empirical applicability of the framework for value chains of high technological intensity has been confirmed with the selection of indicators for all the links of the framework. As an advance, it is also possible to carry out a comparison between segments of value chains in territories of different nature (states and countries in the same comparative universe). Given the reality of the state of Ceará, a territory where jobs with a high level of education are scarce, the framework has applicability in strategy evaluation.

In this way, the research presents the reading of a scenario, even though the Value Chain SCP framework has a dynamic nature and allows the approach to different scenarios and allowing the extension of the work in this sense. To observe, as an example, the susceptibility that shocks cause in the analysis of strategies when the pandemic crisis resulting from COVID-19 occurs, which is the reason that limits the current analysis to the pre-pandemic period, which suggests the opportunity for future work that can incorporate elements of the aforementioned shock.

Given the universe of products generated in the aeronautical value chain, no databases were found that would allow the observance of other categories of performance, such as revenues, costs and added value. The observance of these categories of indicators in commodity value chains is easier given the small range of final products. It can be seen, however, that such a perspective does not constitute an impediment to the application of the Value Chain SCP framework.

The research also limits the sample to territories outside Europe and the United States, given the aim of perceiving similarities with territories that also postulate the upgrading movement similarly to the territory of Ceará. A consultation with experts could help to confirm the strategies outlined for the aeronautical stream in the state of Ceará and its absence is a limitation of this study. The universe of successful strategies in the segments of value chains in the territories excluded in this research configures, in addition, an opportunity for future research.

AUTHORS' CONTRIBUTION

Conceptualization: Gomes HHE; **Methodology:** Gomes HHE; **Formal analysis:** Gomes HHE; **Writing – Original Draft:** Gomes HHE; **Writing – Review & Editing:** Gomes HHE; **Visualization:** Urbina LMS; **Supervision:** Figueirêdo Junior HS; de Andrade D.

DATA AVAILABILITY STATEMENT

All data sets were generated or analyzed in the current study.

FUNDING

Not applicable.

ACKNOWLEDGEMENTS

Not applicable.

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