

## **REGIONAL INNOVATION SYSTEM OF BRAZILIAN AERONAUTICAL INDUSTRY**

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## **ABSTRACT**

There are evidences that the aeronautical industry is a large Brazilian business success example. This success was followed by a significant thickening of the supply chain composed of small and medium-sized technology-based firms, among other suppliers. Considering these companies and their contribution to economic development, this paper proposes to identify and analyze the mechanisms of articulation and territorial governance of the Regional Innovation System located in Metropolitan Region of Paraíba Valley and North Coast, in order to analyze the role of innovation networks for regional development. The methodological approach was grounded in the interpretive vision. The empirical research was conducted through semi-structured interviews with various actors. The research examined innovation as strategic theme in the institutions and the region; public policies to foster innovation; cooperation between the actors; learning processes; processes of innovation diffusion; challenges, barriers and difficulties. The results indicate the need for a new level of maturity in the regional innovation system, with greater coordination of innovation networks and greater integration of the science, technology and innovation base, aimed at broader challenges faced by the territory, in benefit of the socio-economic development of the Metropolitan Region of Paraíba Valley and North Coast. Based on the results, we can conclude that the Regional Innovation System of Brazilian Aeronautical Industry aims to disseminate the culture of innovation as a competitive differential of enterprises in this globalized world. Finally, it is possible to state that the study of Regional Innovation System in the aeronautics industry was very enlightening, to have produced results which can be useful both to the future research on the subject as well as for the development of new solutions for the growth of the companies located in Metropolitan Region of Paraíba Valley and North Coast, in São Paulo, Brazil.

**Keywords:** Planning. Development. Innovation System. Territorial Coordination. Aeronautical Industry.

## INTRODUCTION

The aeronautics industry has characteristics that distinguish it from other industrial sectors, giving it dynamic and peculiar challenges. The sector is knowledge-intensive, economic, and human capital and incurs increasing returns and economies of scale due to the long product development process, usually 5 to 10 years, and its extended life cycle, three decades average. The entry of new firms in this industry is hindered by technological barriers, the high R & D costs and the stringent regulatory environment (MacGuire, 2011). It is also characterized by strong government support, because of the high risks of innovation and high R & D costs.

Given those characteristics, the importance of the aerospace industry to the Brazilian economy, especially for the Metropolitan Region of Paraíba Valley and North Coast (RMVALE), is highlighted by the high growth potential in view of the expansion of the economy, the relevant technology content, the high added value of the product and by the expressive contribution to the trade balance (Montoro & Migon, 2009).

Another key issue to consider in this debate concerns the role of innovation to strengthen a sustainable path of regional development. In fact since combined with other conditions such as chaining the production structure, their patterns of specialization, diversification, and technological trajectories in which they operate its main sectors, fostering innovation and stimulating technology transfer at the regional level are relevant factors. By stimulating innovation and its diffusion within the region, companies in the aeronautics industry located in RMVALE can increase the value of its production and become able to compete in other markets, both nationally and internationally (Marcellino, Avanci & Britto, 2013).

Upon learning, that innovation is an important element in the aeronautics industry and understands innovation as a systemic phenomenon, which occurs in an economic environment and socio-institutional characterized by territorial specificities, the clipping regional innovation systems to show the functional discussion of some important challenges for the economic development of RMVALE.

Accordingly, this paper proposes to identify and analyze the mechanisms of articulation and territorial governance of the Regional Innovation System located in Metropolitan Region of Paraíba Valley and North Coast, in order to analyze the role of innovation networks for regional development.

## REGIONAL INNOVATION SYSTEM

The concept of innovation system has its roots in evolutionary thought, with its main points being the importance of innovation as a source of productivity growth and the material well-being and understanding of innovation as a broad, dynamic, interdependent and complex process, involving various economic, social, cultural and historical institutions (Casali, Silva & Carvalho, 2010).

Through the innovation system, we seek to understand how the process occurs in emerging technological innovations, both in relation to the emergence and dissemination of elements of knowledge as in relation to transformation into new products and production processes. Casali,

Silva and Carvalho (2010) explain that the complexity of the dynamics of innovation lies in the fact that it is not assumed to be a linear process from basic research to applied research and then for the development and implementation in production. It involves feedback mechanisms and interactive relationships between science, technology, learning, production, policy and demand.

Among the great authors who have developed and used the concept of innovation system Freeman, Nelson and Lundvall can be highlighted, since the end of the 1970s. Freeman and Perez (1988) define innovation systems as organizational and institutional structures of support to technological changes, which have predominantly national character. The concept of innovation systems refers to a wide range of attributes, which involves formal and informal social arrangements, structures and public and private institutions, rules and conventions in a historical perspective.

Lundvall (2010) builds two innovation system definitions. In the narrow sense, it refers to the creation of organizations and institutions involved directly in the search and exploration of innovations (R & D departments, universities and research institutes). In a broad sense, the concept involves aspects of economic structure and institutional configuration that affect (with varying intensity) learning as well as search and exploration (by production system) market and financial system, without which there is no innovation.

Although the national perspective has usually been adopted, depending on the purpose of the work or the particular characteristics of the country in question, one can work the concept of innovation system in a different level of aggregation (Casali, Silva & Carvalho, 2010). The main argument is that the various regions that constitute a country have its own historical, cultural, political and economic characteristics, differing from each other and forming their own innovation systems. Therefore, the concept of regional innovation system was developed in the early 1990s (Cooke, 2007), leading to the rediscovery of the importance of regional resources in stimulating technological and economic development.

In his work, Diniz (2001) cites several authors who emphasize this idea. To Storper (1995, 1997), the social and cultural environment plays a crucial role in regional or local development through the interactions between institutions. Putnam (1970) emphasizes the importance of civil society and traditions in regional economic development. Saxenian (1990) studies the role of culture in the development of Silicon Valley. Amin and Thrift (1993) define the concept of institutional robustness to point the importance of relations among cultural, social and political institutions, and the local or regional economy.

Asheim and Coenem (2005) summarize the importance of the local dimension:

- Presence of human capital, interactions between firms, schools, universities, training centers.
- Formal and informal networks between sellers and buyers to do business and exchange of information, through planned or casual meetings.
- Synergies or "surplus" innovative, shared culture.
- Legitimate existence of strategic powers of administrative in areas such as education, innovation and business support. For them, the learning process is predominantly interactive and socially immersed in the institutional and cultural environment. The local cooperation takes over as determinant key in the local capacity to compete.

Briefly, a regional innovation system can be understood as a set of public and private actors, formal institutions and other organizations, interacting with each other, work in order to drive the generation, use and dissemination of knowledge (Doloreux, 2003; 2004; Doloreux & Bitard, 2005). Thus, the system does not integrate only private firms, but also includes research

organizations, funding institutions and governance, technical training institutes and universities, policymakers and also the social and cultural patterns related to innovative activity incorporated into the regional context.

## BRAZILIAN AERONAUTICAL INDUSTRY

The global aeronautical industry has a global dimension, consisting of a small number of global players, which, given the enormous technological complexity, reflected in the high development and production costs, concentrate more and more on project activities and aircraft assembly, requiring a wide range of components and services of a chain of suppliers of small and medium size.

Currently, the aeronautics industry is one of the largest and most innovative sectors of the Metropolitan Region of Paraíba Valley and North Coast (RMVALE). In the international environment, this region is considered the most important in the world in this sector, as well as Montreal in Canada, Wichita in the United States and Toulouse in France (Moraes, 2014).

In Brazil, Embraer is the productive and technological nucleus of the aeronautical segment, articulating a set of SMEs that are suppliers around their economic activities. According to Montoro and Migon (2009), between 80 to 90% of revenues from these SMEs are linked to the demand of Embraer. Given this context, Table 1 presents some measurable results of economic activity in the aerospace industry.

	2009	2010	2011	2012	2013	2014
<b>Annual Turn Over (US Billion)</b>	6.8	6.7	6.8	7.5	7.0	6.4
<b>Exports (US Billion)</b>	5.17	4.99	5.1	6.01	5.4	5.1
<b>Employment</b>	24000	22600	22900	25064	26239	24000

*Table 1: Economic Contribution of the Aerospace Sector in Brazil between 2009-2013, Source: AIAB (2015)*

The data provided the Aerospace Industries of Brazil (AIAB, 2015) stands out that much of this economic performance is due to the aeronautical<sup>1</sup> segment, responsible in 2014 by 84.24%, the result of such indicators. In the same year, the defense<sup>2</sup>, space<sup>3</sup> and other related segments accounted for 75.40%; 0.0012% and 0.0015%, respectively.

## METHODOLOGY

The scientific method offers two main types of approaches: (a) the rationalistic method, based on positivism and (b) the interpretative approach, centered on the depth of the phenomenon

<sup>1</sup> The aeronautical segment offers a wide range of products such as: aircraft, helicopters, their joint and structural parts, engines, components and parts, radio communication and navigation equipment, systems and embedded devices and the air traffic control.

<sup>2</sup> The defense segment offers in addition to aircraft specifically designed for different types of mission, the integration of systems, equipment, components and parts, unguided weapons and intelligent.

<sup>3</sup> In the space segment, provides small satellites and its structures, on-board equipment including payloads, sounding rockets and launch vehicle, various systems and parts, propulsion, respective segments of land and services involving the application of satellite imagery, and consulting and other specialized services.

studied, seeking explanations about the causes of phenomena and their development (Hart, 1998). The studies carried out by the main authors of the French school of innovative environment (*milieu innovateur*) using the interpretive approach to analyze and explain the phenomena of articulating the cooperation and dynamic place of learning networks. The purpose of this school is to debug / deepen the discussion around the phenomenon - innovative environment. So the predominant methodological approach was interpretative.

The emphasis of the methodology was characterized by qualitative approach, as the nature of the study aimed to deepen the analysis of the phenomena that reveal the relationships within the regional innovation system in the aeronautical sector located in Metropolitan Region of Paraíba Valley and North Coast, in São Paulo, Brazil.

Therefore, the data collection procedure was the semi-structured interviews and in depth with the agents that make up the regional innovation system analyzed. This data collection technique gave the interviewer flexibility to order and ask the right questions during the interview, which becomes richer given the opportunity to explore the issues from the responses obtained.

The data analysis procedure is based on Miles and Huberman (1994). For these authors the qualitative analysis consists of three procedures:

- (1) *Data reduction*. This refers to the process whereby the mass of qualitative data you may obtain – interview transcripts, field notes, observations etc. – is reduced and organized, for example coding, writing summaries, discarding irrelevant data and so on. At this stage, try and discard all irrelevant information, but do ensure that you have access to it later if required, as unexpected findings may need you to re-examine some data previously considered unnecessary.
- (2) *Data display*. To draw conclusions from the mass of data, Miles and Huberman (1994) suggest that a good display of data, in the form of tables, charts, networks and other graphical formats is essential. This is a continual process, rather than just one to be carried out at the end of the data collection.
- (3) *Conclusion drawing/verification*. Your analysis should allow you to begin to develop conclusions regarding your study. These initial conclusions can then be verified, that is their validity examined through reference to your existing field notes or further data collection.

## **ANALYSIS OF RESULTS: THE REGIONAL INNOVATION SYSTEM IN THE METROPOLITAN REGION OF PARAÍBA VALLEY AND NORTH COAST**

Metropolitan Region of Paraíba Valley and North Coast, that it is shown in Figure 1, was created by the complementary state law number 1166, to January 9, 2012 and is one of five metropolitan regions of São Paulo State. It is formed by the union of 39 municipalities grouped into five sub-regions.



*Figure 1: Metropolitan Region of Paraíba Valley and North Coast Map, Source: Emplasa, 2011*

This region stands out for quite diverse economic activities, in particular the automotive, aeronautical, aerospace and warlike industries. These industries are concentrated in the municipalities located in the axis of the Presidente Dutra highway (which connects São Paulo city to Rio de Janeiro). It is noteworthy that the region has other economic activities such as port and oil activities in the North Coast and tourist activities along the Mantiqueira Mountains, in the North Coast and Historic Valley.

Among the main institutions and companies located in the region, we highlight the DCTA, INPE, Embraer, Ambev, General Motors, Ford, Yakult, Petrobras, Volkswagen, Panasonic, LG, Johnson & Johnson, Comil, BASF, Brazil AGC glasses, Liebherr and others. And it is also a regional center of commerce and services; with the presence of major universities as EEAR, FATEA, FATEC, IFSP, ITA, SENAI, UNESP, UNIFESP, UNIP, UNISAL, UNITAU, UNIVAP and USP.

According to the characteristics described above, the aeronautical sector accounts for 40% of the region's economic activity. As already mentioned, the innovation is an important element in the aeronautics industry and understands innovation as a systemic phenomenon, which occurs in an economic environment and socio-institutional characterized by territorial specificities, the clipping regional innovation systems to show the functional discussion of some important challenges for the economic development of RMVALE. According to that, the Figure 2 shows the composition of Regional Innovation System.

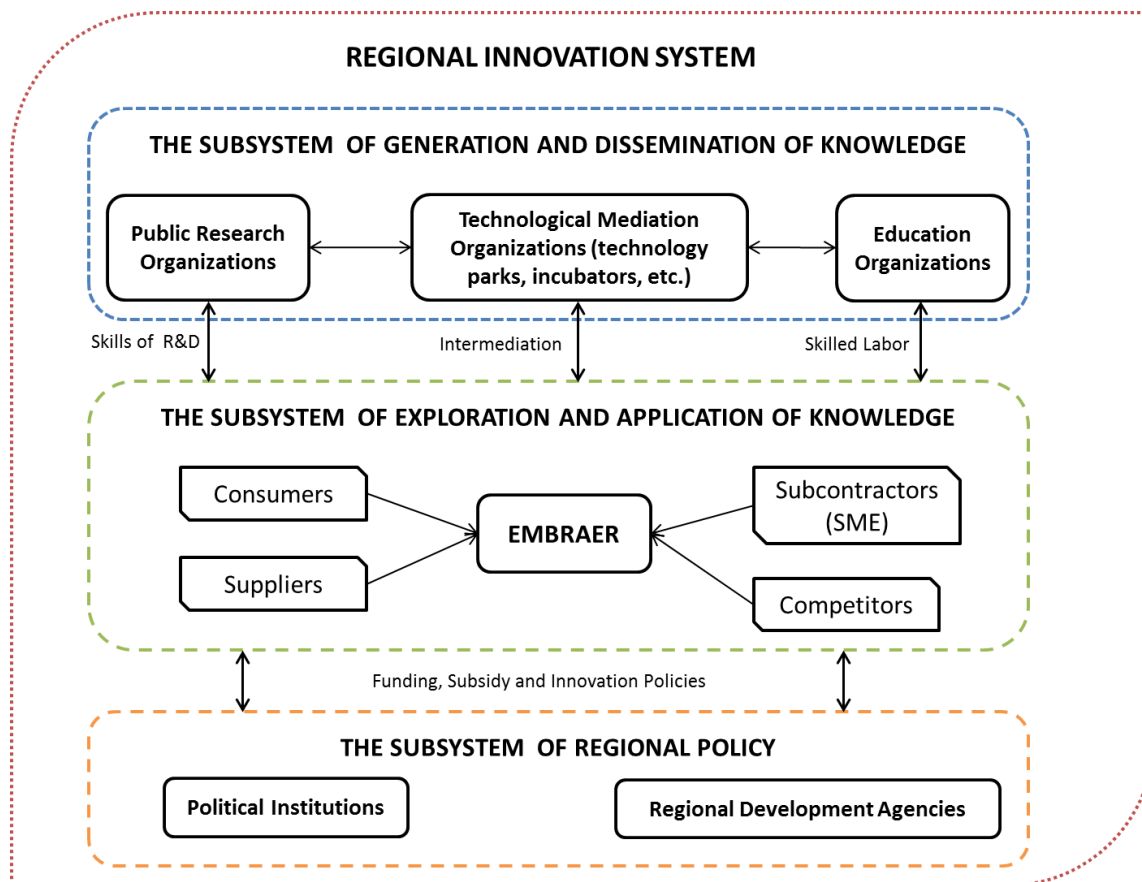


Figure 2: Composition of Regional Innovation System

Analyzing Figure 2, we verified that the regional innovation system of Brazilian aeronautical industry is dynamic. The dynamism arises from the interaction, the intense interaction between the subsystem of generation and dissemination of knowledge and the subsystem of exploration and application of knowledge.

This interaction is marked by the transmission of economically useful knowledge and skills of R&D by the Education Organizations, Public Research Organizations and Technological Mediation to production chain of the aeronautical industry that has technological needs. It is important to explain that in addition to the transfer of knowledge, there is exchange of human resources and financial resources, providing amplification of the powers provided by the transmission of knowledge.

Nowadays, the public research organizations are comprised of two major research centers: National Institute for Space Research and Aerospace Technology and Science Department. The National Institute for Space Research (Portuguese: *Instituto Nacional de Pesquisas Espaciais* - INPE) is a research unit of the Brazilian Ministry of Science and Technology, whose main goals are fostering scientific research and technological applications and qualifying personnel in the fields of space and atmospheric sciences, space engineering, and space technology. INPE is located in the city of São José dos Campos, São Paulo.

The Aerospace Technology and Science Department (Portuguese: *Departamento de Ciência e Tecnologia Aeroespacial* - DCTA) is the national military research center for aviation and space flight of Brazil. It is subordinated to the Brazilian Air Force (FAB). It coordinates all technical and scientific activities related to the aerospace sector in which there

are interests by the Ministry of Defense. It was established in 1953. It currently employs several thousands of civilian and military personnel.

Already, the technological mediation organizations are comprised of one Technology Park and one a Business Incubator (INCUBAERO). The main objective of the Technology Park of São José dos Campos is promoting the emergence, growth and consolidation of innovative companies, operating in high density technology segments. The Aeronautical incubator (INCUBAERO) is a business incubator and projects created by Casimiro Montenegro Filho Foundation to develop the aerospace industry, in partnership with the General Command of Aerospace Technology / Institute of Aeronautics and technological development entities.

Education organizations are formed by three major universities offering engineering and management courses, both at undergraduate and graduate level, focused on the aeronautical sector and these universities are: ITA, UNITAU and FATEC.

Added to these two subsystems, there is a third subsystem, consisting of a governance basis, which meets the coordinating body function, participating in interactive learning processes, leading them through funding instruments more actively through multiple types of incentives. The subsystem of regional policy is comprised of Political Institutions and Regional Development Agencies.

It is important to explain that the interaction between the subsystem of generation and dissemination of knowledge and subsystem of regional policy is characterized by the exchange of funding, subsidy and innovation policies.

Based on the collected data, the main policy of incentive for innovation to promote growth of the aeronautical sector in the Metropolitan Region of Paraíba Valley and North Coast are: Regional Plan of Action in Science, Technology and Innovation; Technological Industrial Policy and Foreign Trade and Regional Strategy for Science, Technology and Innovation. Political institutions that are involved in this policy are: the city hall of São José dos Campos, the Association of Aerospace Industries of Brazil and the Commercial and Industrial Associations of Municipalities of São José dos Campos and Taubaté. Based on the interviews, we noted that these institutions are responsible for developing and overseeing regional strategies for innovation in institutions and companies in the aeronautical sector.

By analyzing the financing needs, we verified that there is a large public institution that provides support to businesses. This institution is FINEP whose mission is to stimulate economic and social development in Brazil by promoting science, technology, and innovation in companies, universities, technology institutes, and other public and private institutions

According to the agents interviewed, FINEP provides refundable and non-refundable financing. FINEP support covers all stages and dimensions of the scientific and technological development cycle: basic research, applied research, innovation, and product, service and process development. FINEP also supports nurturing technology-based companies, establishing technology parks, structuring and consolidating research processes, development and innovation in established companies, and developing markets. Respondents indicated that FINEP only funds pre-production stages and does not invest in production expansion. For this type of support, FINEP directs those interested to BNDES.

In sum, the results indicate the need for a new level of maturity in the regional innovation system, with greater coordination of innovation networks and greater integration of the science, technology and innovation base, aimed at broader challenges faced by the territory, in benefit of the socio-economic development of the Metropolitan Region of Paraíba Valley and North Coast.



## CONCLUSION

With regard to innovation as the central theme of the strategy in the region and institutions, we noted that the Metropolitan Region of Paraíba Valley and North Coast stands out as a consolidated innovative environment, with strong infrastructure and prominent national research institutions. The study found that the performance of the institutions occurs around their networks around the theme science, technology and innovation. In this case, studies about regional innovation system are relevant.

Based on the results, we can conclude that the Regional Innovation System of Brazilian Aeronautical Industry aims to disseminate the culture of innovation as a competitive differential of enterprises in this globalized world.

Finally, it is possible to state that the study of Regional Innovation System in the aeronautics industry was very enlightening to have produced results which can be useful both to the future research on the subject as well as for the development of new solutions for the growth of the companies located in Metropolitan Region of Paraíba Valley and North Coast, Brazil.

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