DOI: 10.5902/19834659 21341

DIFFERENCES BETWEEN THE PRACTICES OF INNOVATION ENVIRONMENTS FROM NATIONAL INNOVATION SYSTEMS WITH DISTINCT MATURITY LEVELS: INSIGHTS FROM BRAZILIAN AND FRENCH CASES

Diferenças entre as práticas de ambientes de inovação de sistemas nacionais de inovação com maturidades distintas: evidências do caso brasileiro e francês

Submission: 04/03/2016
Accept: 27/02/2018

Patrícia Benassi Mathieu[1]
Ivete Delai[2]

ABSTRACT

The aim of this study is to identify the different practices that exist in innovation environments that belong to National Innovation Systems with distinct maturity levels: France (advanced) and Brazil (in development). A case study was carried out comparing the Technological Park of São José dos Campos and the Pôle de Compétitivité HYDREOS regarding seven dimensions: governance, strategy, external relationships, external environment, legal context, infrastructure and funding mechanisms. As a result, the initial premise that the environment inserted into the mature system presents a more comprehensive set of the studied dimensions can be observed. The main differences identified (or improvement opportunities for the Brazilian environment) refer to the following dimensions: external relations, strategy, funding mechanisms and governance. Most of these differences directly affect the degree of interaction between the members of the innovation environment and between them and outsiders, the diversity of actors and the relationship rules, which are key elements of a national innovation system.

Keywords: innovation, innovation environments, Pôle de Compétitivité, technology parks

1 Hold a bachelor in Production Engineering from the Federal University of São Carlos, 2014) and a Master 2 from the Ecole National des Supérieure en Génie des Systèmes Industrielles (France) in Innovation Management and Industrial Design ("Management de l'innovation et Design Insdutriel"- 2012). E-mail: benassi.p@gmail.com. ORCID: https://orcid.org/0000-0002-7743-112X

2 Adjunct Professor at the Department of Production Engineering of the Federal University of São Carlos (UFSCar), São Carlos, Brazil. I hold a bachelor in Management, a Master and a PhD in Organizational Management and a Pos-Graduate Certificate in Sustainable Business (PCSB) from the Cambridge Institute for Sustainability Leadership – University of Cambridge/UK. E-mail: ivete@dep.ufscar.br
ORCID: https://orcid.org/0000-0001-6367-0181

RESUMO

Este trabalho visa identificar as diferenças nas práticas de ambientes de inovação inseridos em Sistemas Nacionais de Inovação (SNI) com níveis de maturidade distintos: França (maduro) e Brasil (não maduro). Para tanto, foi empregada abordagem qualitativa descritiva via estudo de caso das práticas do Parque Tecnológico de São José dos Campos (BR) e do Pôle de Compétitivité HYDREOS (FR). Para tanto, foram analisadas as práticas relativas às dimensões: governança, estratégia, relacionamentos externos, mecanismos de financiamento, ambiente externo, contexto legal e infraestrutura. Como resultado tem-se a confirmação da premissa inicial de que o ambiente inserido no SNI maduro apresenta um conjunto mais compreensivo de práticas. As principais diferenças identificadas referem-se às práticas de relacionamentos externos, à estratégia e à governança. Todas elas afetam, direta ou indiretamente, o grau de interação entre os membros do ambiente e entre estes e agentes externos, a diversidade de atores e as regras de relacionamento, que são compenentes de um SNI.

Palavras-chave: *inovação, ambientes de inovação, polos de competitividade, parques tecnológicos.*

1 INTRODUCTION

The term "innovation" is related with technological progress and new product development to create competitive advantage (FILHO; GONÇALVES; PARDINI, 2008). Strategically it is important not only for the innovative company that develops it, but also for the country where investments in creating new technology are made.

In this context, National Innovation Systems (NISs) play a major role in providing infrastructure, incentive policies and financing strategies to support the innovation development in a country. Edquist (2004) defines it as a set of actors and elements (economic and institutional) that work with synergy and interaction to develop products and process, with different perspectives of analysis, which are strategic and important for the development and competitiveness of nations.

Innovation environments are one of these components that support the technological advancement of this structure. They consist of the place and context where the innovation is developed. In other words, they are differentiated environments organized by public or private institutions that allow and facilitate innovation. According to Zouain (2003), these environments help develop products and processes based on technology, because they have conditions that maximize the results of the generated process, reducing the associated risks. Despite the fact they have the same goal, the environments can be organized and named in different ways: technological parks, *poles de competitive* (competitiveness poles), technology-based incubators or technopoles. The environments are mostly influenced by the context they belong to.

As each country has a specific structure and innovation environments, they may present different maturity levels. This means that they can present different levels of articulation between the components of the system and distinct impacts on the innovation rates (measured by economical and development indexes). Albuquerque (1999) classifies NISs as "mature", "catching up" and "non-mature".

Despite its good macroeconomic performance, innovation in Brazil is still a weak point, and is classified as a "non-mature" NIS (ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT, 2013). On the other hand, France is classified as a "mature" system, as it is a reference model concerning the institutions that comprise its innovation incentive policies (ARBIX, 2010).

In this context, the question that underlies this research emerges: what are the differences that can be identified between the innovation environments of a "non-mature" (Brazil) and a "mature" (France) NIS? This paper answers this question based on a comparative case study between a Brazilian and a French environment. Therefore, it identifies the different practices that exist in the latter that can be implemented in the former to improve it.

Despite the importance of innovation environments and NISs, few studies have attempted to understand and compare the differences between "mature" and "non-mature" environment practices[1]. One of the few studies was developed by Silva (2009) who analyzed five French poles (but not the one mentioned in this study) and four Brazilian environments (including the one in this research). The author used three out of the seven dimensions investigated in this research, as a basis for identifying good practices for creating an innovation environment in the city of Sorocaba, Brazil. Thus, this work contributes to the literature by presenting a more detailed set of practices of a "mature" environment and its differences from the "non-mature" one, which can be used by national environments for evaluation and improvement purposes. In addition, it helps to understand the specific characteristics of "mature" and "non-mature" systems, detailing the model proposed by Albuquerque (1999).

Besides this introduction, this paper has four more sections. The first section presents the concept of NIS, innovation environments and their characteristics. The second section describes the research method used in this study and the third presents the results: convergent and divergent points between both environments and opportunities for improvement. Finally, the conclusions and proposals for future studies are presented.

2 NATIONALS INNOVATION SYSTEMS AND INNOVATION ENVIRONMENTS

2.1 Nationals Innovation Systems (NISs)

Innovation is the implementation of a significantly improved product or service, process, new marketing method or a new organizational method in business practices, work environment or external relations (ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT, 2005). Although the term is popularly linked to the creation of new technologies and new companies, innovation, according to the above concept, is transversal, that can be applied to processes, organizations, business models and the most diverse areas of the economy, "mature" or "non-mature" (ARBIX et al, 2010). Thus, innovation is important for companies and for the growth of countries and has received increasing attention from government policies.

Innovation should not be treated as a simple process based on basic scientific research, but should be structured and well defined (ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT, 2005). It is a learning process that is facilitated and amplified when developed in an interactive and integrated way (EDQUIST, 2001) between the various social actors in an organized way (ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT, 2005). And it is precisely in this structuring that lies the importance or role of NIS. When they are structured in a planned way they can strengthen the development of technologies and the progress of the nation (FREEMAN, 1995).

Edquist (2001) presents a more generic concept of NIS, which defines all the economic, social, political, organizational and other important factors that can influence the development, diffusion and use of innovations, whether sectorial or regional. While the regional ones refer to the innovation system of a certain geographic region of a country or parts of different countries, the sectorial ones present more specific focuses on certain technological or product areas (EDQUIST, 2001).

NISs present two groups of basic components that influence each other: the actors that comprise it – the organizations –, and the interactions and relationship between them provided by institutions (EDQUIST, 2001; ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOP-

1 According to research carried out using the Science Direct, Emerald, Scopus and Teses USP databases, as well as the Brazilian academic journals *Gestão, Inovação e Tecnologias, LOCUS* and *Revista de Administração e Inovação.*

MENT, 2005; SOUZA, 2005). Organizations are formal structures with explicit purposes and they are consciously created. Among these, Edquist (2004) highlights companies, scientific and technological organizations (which develop basic knowledge and formal education), development organizations, entrepreneur capital and the government. Institutions define the routines, habits, rules, practices and laws that regulate relationships and interaction between individual, groups and organizations (EDQUIST, 2001, 2004). For example, the legal systems, norms, national standards and patent legislation (EDQUIST, 2001, 2004).

NISs serve as a reference to understand the different technological dynamics of countries. To characterize them, based on a study including 46 countries and a previous study from Nelson (1993), Freeman (1995) and Patel; Pavitts (1994), Albuquerque (1999) proposes a classification according to its maturity: "mature", "catching up" and "non-mature". This degree of maturity refers to the level of integration between the components of the system, and also how much innovation reflects and is important in the economic system, dynamizing it (NELSON, 1993). To do so, the author uses a set of indicators of science and technology, such as: gross domestic product per capita, generated patents, investments in research and development, published articles, rate of illiteracy and graduates, and the number of scientists and engineers graduated in the country.

According to Albuquerque (1999), mature NISs are countries that have a good balance of investments in science and technology, with an infrastructure that encourages a relationship between key institutions, allowing exchange and interaction between them, generating knowledge and innovation. In these countries, innovation is reflected in the number of generated patents. Some examples of countries in this category are: Belgium, Denmark, Germany, France, Ireland, Italy, Netherlands, the United Kingdom, Austria, Switzerland, Canada, the USA, Japan, Australia, New Zealand and Israel.

The "catching up" group includes countries that are in transition between "mature" and "non-mature". This means that these countries are undergoing a process of accelerated maturation and focus on innovative activities (expanding infrastructure and concentration of scientific development in key disciplines for industrial advancement) (SILVA, 2009). They are countries that have grown in the number of patents and rates in education, as well as advances in research and development, engineering and science. They have the characteristic of investing in scientific infrastructure and the capacity to absorb the technology generated outside the country adapting it to their own national system. Some examples in this category are in East Asia - Korea, Taiwan and Singapore (ALBUQUERQUE, 1999).

Finally, the "non-mature" group includes countries with an unbalanced distribution of investments in science and technology that generate gaps between the institutions involved, as well as educational problems (ALBUQUERQUE, 1999). They are divided into three groups. The first group includes countries with problems of education and low level of development in R&D. The scientific structure shows some level of activity and some innovative actions, but the number of patents and papers is still below those belonging to the "mature" and "catching up" groups. Scientific infrastructure is limited, and few disciplines meet international standards, thus having poor interaction with the technology community. Another important point is that budget issues affect the stability of research groups and their results. This includes countries as Argentina, Brazil, Chile, Venezuela, India, South Africa, Greece, Spain and Portugal.

The second group includes countries with a low numbers of patents in an economic context of growth, good level of education and excellent sources of scientific research, however the results generated by research do not present civil, butmainly military purposes. Therefore, despite technological investments, the effects are weak, since the resources are not well allocated and distributed. It includes systems from countries such as Russia, Bulgaria, Czechoslovakia (now the Czech Republic and Slovakia), Hungary, Poland and Romania.

Finally, the third group includes countries with a good ratio between patents and economic growth but which have a low per capita patent rate: in its more technology-intensive business sector, patents are not important. There is a scientific structure with high levels of activity and a high degree of technological diffusion. Examples of this group are Indonesia, Malaysia, the Philippines and Thailand.

Therefore, the Brazilian NIS is classified as "non-mature" due to a dynamic of interaction that does not allow an adequate connection between science and technology that foments the production of knowledge. In addition, another feature is the presence of foreign or state investments participating in technological production, as well as a regional concentration in the country of technological activities (ALBUQUERQUE; BAESSA; KIRDEIKAS, 2005). On the other hand, the system in France is considered "mature". The country has been through a process of change of its productive structures, demanding efforts and preparation of the society. In addition, coordination and the generation of processes to stimulate innovation are carried out by the highest governmental spheres (ARBIX, 2010).

2.2 Innovation environments

Innovation environments can be defined as delimited spaces that present conditions to develop activities and technological processes with economical purposes to foster innovation (ZOUAIN, 2003). They are structured based on scientific and technological knowledge, supporting the development of innovations and creating a space of synergy between the actors, who can share the same physical space (SILVA, 2009). There are elements from the NIS that act as triggers of innovation.

There are several types of innovation environments: technological parks, science parks, research parks, innovation centers, technopoles, *poles de competivité*, technology-based incubators, pre-incubators or technology hotels, accelerators and the core of technological innovation. Each one with its own characteristics depending on its context (SILVA, 2009).

In this paper, a technological park and competitiveness pole were studied. They are environments with different characteristics and similarities, according to Table 1. Among them are:

- Activities that they develop: both of them offer research and development services to create and apply new technologies, although the Park also presents activities related to production;
- Actors: universities, research centers, government and companies;
- Activity limits (area): poles have a bigger scope given their regional performance, while Parks cover a smaller region near a university or research center;
- Governance: this is the most variable aspect in both cases, as it is specific to each institution or to national standards, in the case of poles;
- Assets: practically the same. Differently, Parks present in house incubators.

Table 1: Main characteristics of Technology Parks and Competitiveness Poles

Environment	Activities	_Actors	Location	Governance	Assets
Technological Park	R&D; Design of prototypes; Productive activities; Technical and managerial support services; Other services.	University; Government; Companies.	Near university/ research centers.	It is variable, according to the formatting of the projects and ownership of the areas.	Incubatofor Research and training centers; Business offices for companies; Laboratories.
Competitiveness Pole	Incentive of generating technologies from projects developed in partnership between companies and research centers (usually focused on a specific theme).	University; Government; Companies; Research laboratories.	Regional (local).	Own management structure; Partnerships and strategic projects in collaboration; Promotes a global environment favorable to innovation.	Companies; Universities; Research and training centers; Laboratories.

Source: Adapted from FIGLIOLI (2007); LES PÔLES DE COMPÉTITIVITÉ, n.d.; SILVA (2009).

3 RESEARCH METHOD

This research can be classified as qualitative applied research with a descriptive character. According to Turrioni and Mello (2012), a descriptive survey seeks to indicate the real situation and describe it, and then the results are analyzed and hypotheses formulated. Therefore, this paper consists of analyzing two distinct competitiveness environments, aiming to define and describe them and then compare the main differences and similarities, providing as a conclusion recommendations that can make suggestions for future studies or applications.

In order to develop it, the case study method was used (YIN, 2015). According to Ganga (2012), one of the purposes of the case study is to explore and better understand a phenomenon in its actual context. This is the focus of this work, whose objective is to identify the differences and similarities between two innovation environments inserted into national systems with different maturity levels.

This case study case was based on the phases proposed by Yin (2015). Initially, the theoretical-conceptual framework was defined. This means that the dimensions to characterize the innovation environments were chosen. To do this, a literature review was carried out where academic and governmental articles on national and international databases were consulted - *Science Direct*, *Emerald*, *Scopus, Scielo* and Teses USP. In addition, the research was extended to entities focusing on innovation - *Les Poles de Compétitivité* (France), *Associação Nacional de Pesquisa e Desenvolvimento das Empresas Inovadoras (ANPEI), Associação Nacional de Entidades Promotoras de Empreendimentos Inovadores (ANPROTEC)* and the Ministry of Science, Technology and Innovation.

As a result, the dimensions of the study were defined and are presented in Table 2. The dimensions chosen were based on the complementarity of the concepts presented by each author. Thus, a large set of dimensions, covering external and internal factors that influence the performance and operation of the innovation environments can be observed.

Table 2: Dimensions for characterizing innovation environments

Dimension	Description	Source
Governance	It comprises the hierarchical structure, the decision-making process, the formalization of the relationship between the actors, rules and the human resources responsible for the functioning of the environment.	ALBUQUERQUE, 1999; GARGIONE, 2011; ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT, 2005; FIGLIOLI, 2007; SILVA, 2009; GARGIONE, 2008
External Relationships	Interactions with internal and external actors, such as universities, research institutes, laboratories, companies, public entities and other innovation environments. They can be local, regional, national and international.	ALBUQUERQUE, 1999; ALBUQUERQUE; BAESSA; KIRDEIKAS, 2005; SOUZA, 2005; FIGLIOLI, 2007; SILVA, 2009;
External Environment	Importance of the geographic environment and the context in which the environment is inserted. Government policies, local actors and cultural values reflect in the innovation environment.	ALBUQUERQUE; BAESSA; KIRDEIKAS, 2005; ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT, 2005; FIGLIOLI, 2007;
Funding Mechanisms	Characterization of the sources of financial resources, beneficiaries and the protocols that are involved.	ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT, 2005; FIGLIOLI, 2007; GARGIONE, 2011;
Legal Context	Legal aspects related to the performance of innovation environments, mainly related to patents and intellectual property rights.	ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT, 2005
Strategy	Measures adopted by the environment for the short, medium and long term to achieve its objectives, to attract new entities, to satisfy the market and keep its business strategy.	ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT, 2005; SILVA, 2009; GARGIONE, 2011
Infrastructure	Resources that the innovation environment owns and has access to. Includes the description of activities carried out in the technological and managerial scope.	ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT, 2005; SILVA, 2009; FIGLIOLI, 2007; GARGIONE, 2011

Source: Prepared by the authors.

Afterwards, the case was planned with the definition of the environments to be studied, the data to be collected and how they would be collected. Two environments were selected as the object of this study. The Technological Park of São José dos Campos represents an innovation environment inserted into a "non-mature" NIS: Brazil. The area in which it is located was acquired in 2006 by the city council and the APTSJC (*Associação Parque Tecnológico de São José dos Campos* – an entity responsible for the organization, development and operation of the park). Legally, it is a social, private and nonprofit organization. It has its own infrastructure that is available to resident companies, which can also be used by external actors. It started its activities in 2009 and has 38 resident institutions (24 small and medium companies, 9 large companies and 3 universities). Among all the sectors of the activities of the institutions in the park, the main ones are: aeronautics, energy, water and environmental sanitation, telecommunications and health.

The second environment studied is the *Pôle de Compétitivité HYDREOS.* It represents an environment inserted into a "mature" NIS: France. Its structure serves as a service to the members of the pole. It has activities related to the theme of "water" (sustainable infrastructures, ecosystems for wetlands and intelligent water management) and covers the Alsace and Lorraine region. The pole began operating in 2010 and its main mission is to improve the performance of the local economy by creating synergy to foster the development of innovative projects and support the members in implementing actions and projects concerning water. It has 100 accredited members among universities, laboratories, trade unions, small, medium and big companies and public organisms.

Regarding the project phase, the data to be collected were defined, as well as the instruments to collect them: by visits and interviews with the environment staff. A research protocol and a semi-structured interview script were created using the dimensions presented in Table 2, descriptive information about the environment (name, size, location and date it was founded) and the people who were interviewed (name, function, studies, and how long they had worked at the pole).

The third phase consisted of collecting data. Interviews were conducted with employees from each pole, which were recorded and transcribed to be analyzed later. For the Park at São José dos Campos a face-to-face interview was held in April, 2014 with its Company and Institution Manager. For the pole in France, an interview by Skype was conducted in May of the same year with the Project Manager.

The next step of the method consisted of analyzing the data. First of all, the content of each interview transcribed in the categories in Table 2 was classified manually. From this classification, the characteristics of each environment were individually identified and described. Finally, a comparative analysis was done on each dimension between the cases to identify convergence and divergence points among them. From the strengths detected in the French environment, opportunities of improvement for the Brazilian case were pointed out.

4 DIFFERENCES AND SIMILARITIES BETWEEN THE STUDIED ENVIRONMENTS

Based on the information collected, points of convergence and divergence were identified between the innovation environments studied. It is important to note that they do not operate in the same way, but they have a common objective: developing the region and bringing benefits to the community by developing research and innovation. Consequently, it is natural that they have differences as each one has its specificity, which will be pointed out throughout this section. The differences and similarities are presented below according to the dimensions defined in the theoretical model (Table 2).

4.1 Governance

This dimension concerns all the elements related to the management and organization of the innovation environment including the organization structure, the decision making process, the rules, procedures and technical and managerial activities developed, human resources management, the actors involved and the relationship between them. Table 3 shows the variances and resemblances between both environments.

Table 3: Summary of convergences and divergences in the Governance dimension of the studied environments.

	Convergences	Divergences
Structure	- Similar operational areas - General Director and Support Director - Not very complex structure, activities linked to people and not to the function	- Different work areas due to different areas of operation (HYDREOS technician and TechPark manager) - Lean structure (HYDREOS) - Board of directors comprising large, medium and small companies, educational and research institutions and public entities (HYDREOS)
Decision making	- Easiness of the process: autonomy for operational decision in the area and strategic decisions concentrated on the board of directors.	None
Alignment rituals	- Rituals adapted to the needs of each one	- The frequency of the participation of the people is different in each one. It is coherent and adapted to their specific needs.
Formal rules	- Non-existent	None
Technical and managerial activities	None	- Better definition between the types of activities (HYDREOS)
Project Managers	None	- Operational team of the pole (project managers) with a close and significant activity (HYDREOS) - The resident companies manage their own projects (TechPark)
Number of institutions	- Quantity coherent with the activity model - Universities, small medium and large companies	Diversity on the nature of the members (e.g. trade unions, laboratories, public institutions) (HYDREOS)
Relationship between environment actors	- Event organization to bring the actors close to each other	- Relationship between members by working groups, workshops and projects (HYDREOS) - Relationship by physical structure (TechPark)
Human Resources	- Adequate training for activities that maintain the operation	- Specialized professionals to deal with the theme of the pole (HYDREOS)
Staff Training	- Technical and management training, without delimited frequency	- Individual Development Plan (TechPark)

Source: Developed by the authors

In terms of structure, both environments present simple and not too formalized arrangements. Basically, there is a General Director who coordinates the teams in the legal, communication, administration and financial departments. For the operational areas, this Director coordinates differently accordingly to their strategy: management (TechPark) and technical (HYDREOS).). In this aspect there is a marked difference in the French pole, which is the board of directors formed by large, small and medium-sized companies, educational institutions and other entities, which provides its strategic direction.

Regarding the decision-making process and its internal management, few differences were identified. In both cases, there are no formal rules and the decision-making process is simplified. With their simplified structured, the departments have autonomy and the processes are agile. The communication standard is similar: weekly meetings between the operational team and the General Director, and also daily alignments for specific subjects.

However, regarding those who are responsible for the project management, there is a considerable difference. The Technological Park in São José dos Campos (TechPark) does not have technical staff, as it does not adopt an active innovation approach with the resident com-

panies. The project management is carried out by the companies themselves and the park helps by providing guidance. Unlike this, the HYDREOS pole works actively in innovation projects and it is structured to meet market demands (it is divided into specific areas of the water theme).The project manager of the pole ensures that innovations are implemented, focusing on the benefits to the region and local community. The project team's role is to identify funding opportunities for certain types of projects that can help put an innovative idea into action

Another significant difference is related to the technical and managerial activities. The HYDREOS Pole has these activities defined and clearly distributed to each team, facilitating the governance process. The board, for example, has a managerial and relationship role, while the technical staff acts directly in executing the project. In the TechPark, these activities are distributed to all teams.

The institution members (to HYDREOS) and residents (TechPark) in both environments are differentiated in quantitative and qualitative terms. While the park has 36 institutions (24 small and medium, and 9 large ones) and universities (3), the pole has approximately 100 members including universities, laboratories, companies of all sizes, trade unions and local public institutions. This difference is linked to the way each environment operates. The TechPark concentrates all institutions in the same physical space, providing a synergy environment that facilitates the development of innovation. HYDREOS helps to develop collaborative Research and Development projects among actors in a territory around a well-defined theme (water), but does not provide the physical space for developing these projects. This is the reason why it has more members and involves public agencies, as well as analysis and research laboratories.

Regarding fostering the relationship between the agencies in both environments, the only common point that they have are the events that enable the exchange of information between the entities. At the TechPark, activities to encourage interaction are not carried out in a structured way by its manager, but occur spontaneously as they share the same physical place (even if they do not work in the same sector of activity). At HYDREOS, there are formal mechanisms for interaction between its members, such as working groups on specific topics and collaborative projects managed by the pole. Although the companies may not have much contact, they discuss the issues at hand in depth. In addition, as the companies have their own members in the board of directors, meetings are a chance for people to make contact and exchange information.

Finally, regarding human resources, in both environments studied, professionals are trained and are trained to carry out their specific activities. However, the HYDREOS pole has a more specialized staff due to its specific theme.

4.2 Infrastructure

The results of the infrastructure dimension comprise the physical resources that the environment has or the external resources have access to. Table 4 shows the similarities and differences identified in the study.

Table 4: Summary of convergences and divergences in the Infrastructure dimension of the studied environments

	Convergences	Divergences
Physical infrastructure	None	- Complete infrastructure (business centers, auditoriums, etc.) and own investments (TechPark)
Public infrastructure	- Dependence on public investments - Importance of local public entities	- Public investments in infrastructure – park assets (TechPark) - Use of public infrastructure to carry out activities (HYDREOS)
Access to external resources	- Not limited to available resources (both search external resources when necessary)	- 100% of resource use is external (HYDREOS)

Source: Made by the authors

Regarding the physical infrastructure, there is a huge gap between the studied environments. While the HYDREOS pole only has its own offices, the TechPark has a complete infrastructure: from the companies' offices and incubators to auditoriums and amphitheaters to hold events. The superiority of TechPark in terms of having its own infrastructure is clear, which affirms that each environment works differently. The fact of concentrating the institutions in the same physical space, despite demanding high investments, guarantees the perpetuity of the actions and is a factor of attracting companies and other institutions to the region, contributing directly to the community. Therefore, the fact of having facilities ends up being a service that this environment can offer. On the other hand, the model used at HYDREOS includes a greater quantity and a variety of members depending on the relationships established between the institutions and their infrastructures.

Concerning access to external resources (laboratories, venues, etc.), the two institutions are similar in terms of non-restriction of using external resources when necessary. Both recommend laboratories, for example, that are not company's members or partners. The French environment uses only external resources while the Brazilian environment has an internal structure adapted to most of its needs.

Regarding the point of maintaining their infrastructure and carrying out their activities, both environments depend on public assistance. This dependency is significant for both (between 50 and 80% of the investments are public in both cases), and are mostly from municipal and regional entities.

4.3 Strategy

The strategy dimension points out the objective or mission of the studied environments and the actions it adopts in the short, medium and long term to meet its objectives. Table 5 summarizes the similarities and differences identified.

Table 5: Summary of convergences and divergences in the Strategy dimension of the studied environments

	Convergences	Divergences
Objective	- Develop innovation and technology by joining different actors. - Bring benefit to the society/ region.	- None
Market	- Local/ regional	- Multisectorial (TechPark) - Single sector: water (HYDREOS)
Areas	- None	- Multi theme: (TechPark) - Specific theme (HYDREOS)
Offered services	- Events	- Technical and specialized, facilitating the development of innovation (HYDREOS)
Lines of actions	- Expansion of members/resident institutions and services	- Driven by a National Strategy (HYDREOS) - Linked to a local strategy (TechPark)
Strategy to attract institutions	- Own web site - Events - Visits to companies	- Attracted by projects (HYDREOS) - Companies' selection program (TechPark)

Source: Developed by the authors

In terms of objective, although they act differently, both environments have the same mission: to promote innovation and research and development, helping to develop the region which they are part of by joining different actors.

They are also similar in terms of the geographical market: most of them work with local and regional institutions. However, they act differently. The principle of the *pôles de competitivité* is their specialization in strategic themes to develop the country. They are established according to the competences of the region, aiming at their development. Therefore, the studied pole only has one theme (water), working with companies of the sector. However, the TechPark is multi-thematic and multisectoral, and takes advantage of the same technological base regarding various sectors.

Regarding the services provided, both of them present common elements, such as holding events and following/guiding members. However, HYDREOS works more actively in developing technology, creating a favorable environment of interaction. It encourages innovative projects, participates in and promotes workshops and group studies, seeks funding sources, encourages certifications, manages projects and disseminates information. The level of maturity of both environments is clear when comparing this dimension. The TechPark is still in the process of developing and building a proposal for specialized services, following HYDREOS line of action.

In terms of long-term actions, the most significant difference is that the HYDREOS strategic plan is linked to a general guideline of all the Competitive Poles (*Les Pôles de Compétitivité*) of the country. The TechPark acts strategically to meet the local government's demands (Prefeitura Municipal de São José dos Campos), but does not have a direct relation with a national innovation development strategy.

Finally, the strategy to attract institutions is similar: posting activities on their own website, participating in events and visiting institutions. Although the emphasis on disclosure is not the same: the Pole involves design institutions while the Park develops a selection program to use the structure and services.

4.4 External Relationships

This dimension entails understanding the types of external relationships carried out by the environments, as well as the different types of actors involved on local, regional, national and international levels. Table 6 summarizes the results of this dimension.

Table 6: Table summarizing the convergences and divergences of the External Relations dimension of the studied environments

	Convergences	Divergences
Universities and Research Centers	- They are strategic - Good relationship	- Formal contact with research centers (HYDREOS) - Direct contact with researchers (HYDREOS) - Contacts for project development (HYDREOS)
Public-private interaction	- Good interaction between institutions of different natures that are members or residents - Close contact with local entities	- Close interaction with Ministries (HYDREOS) - Favorable environment for exchanges between institutions – projects and working groups (HYDREOS)
Partnership	- Low emphasis	- Public entities (HYDREOS) - Research laboratories, international institutions (TechPark)
Relationship with other environments (Parks or poles)	- Informal *Benchmarking*	- The poles participate in a National Program, therefore contacts are easier (HYDREOS). - Grouping poles by theme (HYDREOS) Participation of Park Associations that propose events/meetings (TechPark)
Interaction with other local actors	- Expansion of local contacts for regional development	-None

Source: Developed by the authors.

Both environments are similar in terms of their relationship with universities and research centers. For both these are strategic actors, and therefore, they focus on making partnerships for strategic projects. However, the pole differs by presenting a formal and closer relationship with laboratories and researchers.

As for the public-private interaction, the two environments have a close relation with local entities. The pole, unlike the park, has contact with a larger body – the Federal Government – reflecting a national strategy of competitiveness of the country's companies. There is also a stronger public-private relationship due to the cooperative participation in projects and working groups organized and managed by the pole and its partners.

There is a huge difference regarding the relationship with other innovation environments. In France, as the NIS is "mature", the poles are part of the *Les Pôles de Compétitivité* program. Thus, it is natural that there is a bonded interaction and interchange, as the participating environments have the same origin and global development strategy. In addition to this fact, the poles are clustered into topics of interest to exchange experiences and methods. Moreover, in the same region there is a close contact – although informal – between poles for benchmarking. In Brazil, there is no entity that directly follows the Technological Parks. ANPROTEC (Associação Nacional de Entidades Promotoras de Empreendimentos Inovadores – National Association of Entities Promoting Innovative Enterprises) and IASP (*International Association of Science Parks and Areas of Innovation)* promote national and international meetings between the parks to exchange experiences.

4.5 Funding Mechanisms

In this dimension, the sources of assets were identified which were used by the environments to maintain and develop their projects, beneficiaries and procedures involved for finding and using them. Table 7 summarizes the results of this dimension.

Table 7: Table summarizing convergences and divergences in the Funding Mechanisms dimension of the studied environments

	Convergences	Divergences
Resource sources and Incentives	- Public resources are significant and in a higher percentage - Resources to maintain the local operation - Resources from entities that are interested in/ support R&D - Contribution from associated institutions - Events	- Private resources for own structures installed in the premises of the park (TechPark) - Project investments (HYDREOS)
Collection process	- Public procurement, where each institution has a different process - The delays are respected	- Expertise in public procurement for certain types of projects; one of the services offered by the pole (HYDREOS).
Beneficiaries	- Indirect: local community - Investments in specific projects or specific companies have the involved companies as beneficiaries	- Investments that become assets (infrastructure), the legal beneficiary is the park and the indirect ones are the resident institutions (TechPark).

Source: developed by the authors

The two studied innovation environments have public and public institutions as a source of resources, in addition to their own funds. In both, the public financial resources are very representative and significant. Most of them are from local entities (city or region). In addition, they use resources from foundations, financing bodies and other public entities that leverage and invest in research and development, supported by the national strategy. Another point of similarity that should be highlighted is that part of the resources comes from member institutions or residents. It means that there is a "fee" paid by the institutions to be associated. In addition, another source is the events organized by the environments.

In both cases, when there is public funding there is public procurement, in which the process and procedures are established by each institution. As a result, when the public notices are announced, both innovation environments follow the deadlines, sending the necessary documentation. However, HYDREOS stood out as it advised companies to send documentation to the funding process, making this activity part of its portfolio of services.

Finally, following the objectives of innovation institutions, the direct beneficiary of all investments and actions is the population of the region. Investments generate employment and local development. In the TechPark and the pole, some specific resources are meant only for a few companies. This is because they might participate in specific projects that receive investments or because they are benefiting themselves. When companies invest themselves, it is natural that the assets and return of investments belong to them.

4.6 External Environment

In this dimension, the impacts of geographic environment and the context in which the environment is inserted are discussed. It includes government policies, local actors and cultural values. Table 8 summarizes the results identified.

Table 8: Table summarizing convergences and divergences in the External Environment dimension of the studied environments

	Convergences	Divergences
Regional, national and international policies	- They are sensitive to changes - Indirect impact in policy changes for industries (reduction of investments)	- More dependent on national and regional policies (HYDREOS)
Influence of the region	- Potential of development and favorable conditions	- In-depth study to implement the innovation environment (HYDREOS)

Source: developed by the authors

The two innovation environments are influenced by regional and national policies, and less influenced by international ones. These policies influence and impact the investments applied to the environments. This can be considered as a problem, as any change affects them directly. The Tech Park suffers less impact, because it has assets and infrastructure that belongs to private institutions. On the other hand, the pole does not have its own infrastructure, and therefore it does not survive without public investments (it explains its current strategy to reduce public assets and increase private ones). Thus, it can be said that there is less dependence on policies that directly affect the Brazilian environment compared to the French one, but in both cases they are sensitive to policy variations.

In both of them, the choice of the physical installation of the environment was analyzed and studied. Both regions present favorable conditions to develop innovation (concentration of universities, research centers, enterprises, etc.). However, the creation of the pole came from a demand from national agencies, creating opportunities to develop all regions.

4.6 Legal Context

In this dimension, we identify the main legal aspects related to the performance of innovation environments, especially concerning patents and intellectual property. Table 9 summarizes the similarities and differences identified.

Table 9: Table summarizing the convergences and divergences in the Legal Context dimension of the studied environments

	Convergences	Divergences
Patents and intellectual property rights	- Patents belonging to the developer institutions themselves	- None
Collaboration projects	-Negotiation between participating companies	- They advise consultants or professional to address this subject (HYDREOS)

Source: developed by the authors.

In both cases, the patents generated in the projects belong to the institutions involved and not to the Technical Park or Pole. However, in the long term, the Park plans to have the know-how to create technological development for generating patents because it does not have technical staff that can do this. The pole has the scientific competence to generate patents, but it has no interest in implementing it.

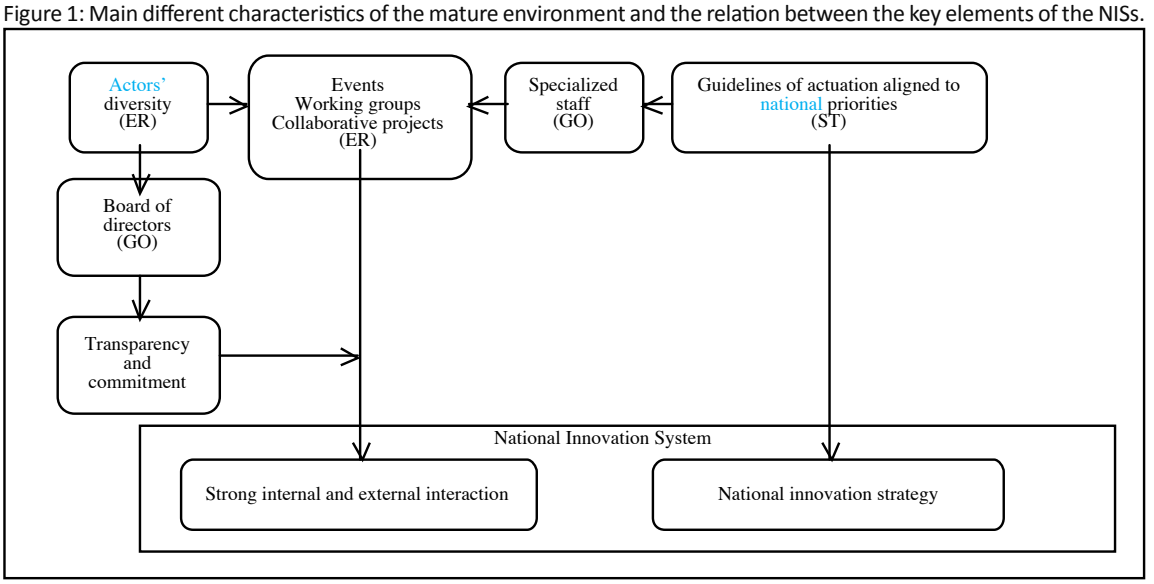
In terms of collaborative projects, the studied environments resemble each other. It is not common to carry out projects in the TechPark, but when this happens, there is an agreement among the participating institutions on intellectual property rights, and the park does not interfere in this negotiation. In the pole, it is common to have collaborative projects, but the park does not participate in the negotiation between the involved parts. It recommends and guides specialists in intellectual law.

5 DISCUSSION OF RESULTS AND OPPORTUNITIES FOR THE BRAZILIAN ENVIRONMENT

This section points out and discusses the main differentiating characteristics of the environment inserted into the National Innovation System that is “mature”. In addition, it suggests, from this analysis, improvements for the Brazilian environment. Although they act differently, there are aspects that can be improved, since they have the same goal: promoting the local de-

velopment by the innovation. Figures 1 and 2 present, respectively, a summary of the differentiating characteristics between the environments and their relation with the NIS, and the relation of the main suggestions for improvement.

Figure 1: Main different characteristics of the mature environment and the relation between the key elements of the NISs.

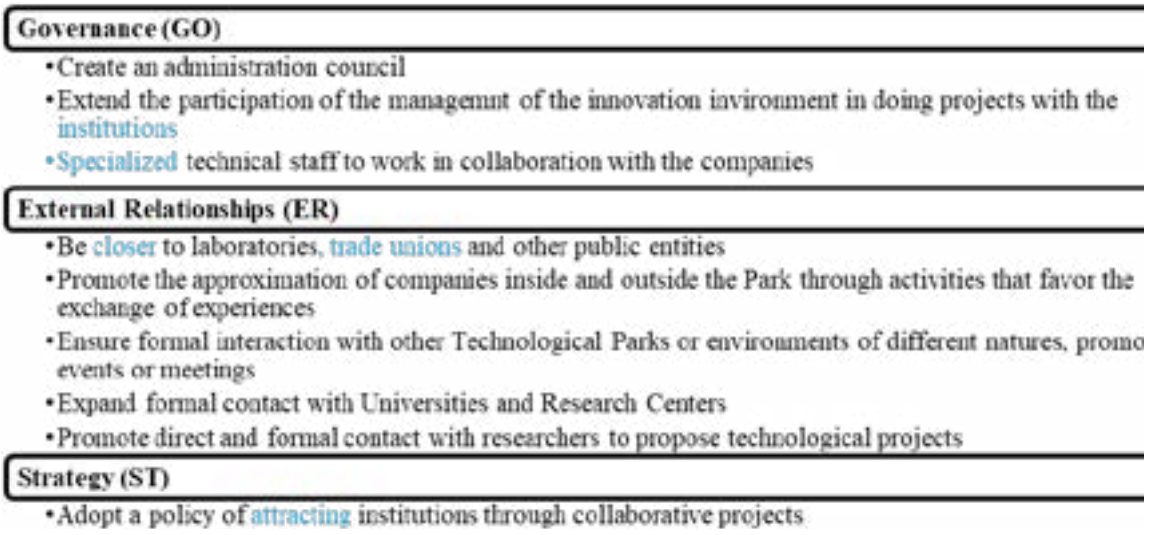


Source: developed by the authors.

The divergences between the environments identified in the previous section validate the premise that the environment positioned in a "mature" NIS demonstrates a wider set of competences and characteristics that facilitate the innovation development. This can be observed mainly in the dimensions of external relationships, governance and strategy.

The dimension with the biggest quantity of distinguished characteristics is the **External Relationships.** This is a critical aspect of the maturity of an NIS. As innovation is a learning process that is facilitated and amplified when developed in a structured way between the organizations (EDQUIST, 2001), encouraging and promoting structured interaction can amplify and maximize the potential to reach it (ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT, 2005; ALBUQUERQUE, 1999). That is why one of the great functions of a (national) innovation system is to promote networking between markets and the integration of organizations into learning and innovation (EDQUIST, 2004). Thus, countries with "mature" systems have an infrastructure that allows a correlation between key institutions, allowing the exchange among them, generating knowledge (ALBUQUERQUE, 1999).

Figure 2: Summary of opportunities to improve the Brazilian environment identified in the study



Source: developed by the authors.

As shown in Figure 1, the distinguishing characteristics in this dimension are the diversity of involved actors and the active and systematic interaction among them. Firstly, the "mature" environment presents a wide variety of actors involved in activities and in its structure. It involves companies of various sizes; national, regional and municipal government agencies; trade unions, research laboratories, universities, research centers, researchers and other innovative environments (poles or parks). Secondly, the interaction between this vast set of actors is actively and systematically encouraged by promoting events, developing collaborative projects, participating in working groups and discussing specific themes. In addition, there is an interaction with other poles to exchange experiences and benchmarking. These characteristics positively impact the generation of knowledge and innovation given the combination of different knowledge and skills from the involved actors and the depth of their relationships (EDQUIST, 2004).

Considering this, the Brazilian environment could expand its interaction mechanisms because it is practically limited to the contact promoted by the physical group of the entities that occupy its installations and the organization of some events. To do this, some actions can be proposed:

- Promote the relationship between the entities by activities that help exchange experiences, such as the incentive of collaborative projects, the creation of working groups to discuss transversal themes that may interest different sectors of activities.
- Increase the proximity with laboratories, trade unions and other public agencies to extrapolate the borders of the institutions installed in the Park and expand the social contact network, even if they are not resident. This might contribute to the creation of a favorable environment for research and development.
- Ensure formal interactions with other Technological Parks or innovation environments (regional, national and international; with the same theme or not) holding events or meetings. This contact is important not only for benchmarking, but to create a global integration that encourages the development of the country.
- To strengthen the formal contact with Universities and Research Centers, because in Brazil, there are qualified institutions that can be used to spread knowledge and bring benefits to the community.

- Promote the direct and formal contact with researchers to propose and develop technological projects.

In addition, governance was identified as a difference in this research. It is important to ensure the adequate management of the environment and the structured relationship between its members (ALBUQUERQUE, 1999; ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT, 2005; FIGLIOLI, 2007; SILVA, 2009; GARGIONE, 2011). In this case, three main differences were identified, according to Figure 1. Firstly, the environment of a mature NIS is distinguished by having an administration council that defines the long-term guidelines and is formed by representatives of various stakeholders involved. It generates more transparency and commitment by all actors. In addition, it is different as it has an internal team with specialized knowledge to develop projects together with the other actors, making the environment a protagonist in identifying opportunities and developing innovation. Finally, it presents a larger number of members involved. There are more than one hundred, three times the Brazilian case. As a result of these practices we have a closer relationship or interaction between a large and diverse set of agents in a structured way. It helps the creation of knowledge and its transformation into innovation, which is one of the key characteristics of an NIS.

In terms of **Governance**, three opportunities of improvement for the "non-mature" NIS were pointed out:

- The creation of a board of directors with the involved actors as members. This increased their participation and commitment. In addition, it would be a way of interacting and encouraging the cooperation between the entities and ensure the transparency of the management of the environment.
- More participation of the managers and staff of the innovation environment in projects with companies. This means offering specific products to encourage innovation project development and to create opportunities that help companies to be more competitive.
- Creation of a specialized technical staff to work with the companies. As they are specialized, it is easier to help the institutions improving the service level and the results in terms of scientific research.

The last dimension to be highlighted is **Strategy**. It comprises the objective or mission of the studied environment, the actions adopted in the long, medium and short term to meet its objectives. It also comprises its focus and general guidelines, the services proposed and the strategy for attracting companies (ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT, 2005; FIGLIOLI, 2007; SILVA, 2009; GARGIONE, 2011).

In this case, as shown in Figure 1, the main difference lies in the fact that the focus and the general guidelines of the environment are aligned with the national innovation strategy. The pole is part of a group of several poles created by a national strategy that seeks regional development and, consequently, the national one. This point shows the maturity of the NIS, in which the coordination and the creation of process to stimulate innovation are carried out at a government level (ARBIX et al, 2010).

From this context, two improvement opportunities can be pointed out:

- Adopt a policy of institutions attracting diffusion of collaborative projects. A policy that encourages the industry as a whole or non-competitive companies that may have common interests but have difficulties (investment or knowledge) to develop collaborative projects. This strategy also contributes to the creation of a synergistic environment and can bring good results to research and development with complementarity.
- Link the strategy of the innovation environment to the national development strategy of the country. This ensures that all the environments that comprise the NIS are aligned and work together for the benefit of the country. However, this is an action that depends on the macro political context of the country.

6 FINAL CONSIDERATIONS

The aim of this paper was to identify the main differences between innovation environments that are located in NISs with different maturities. As a result, some interesting conclusions about the innovation environments can be pointed out.

Firstly, the environment inserted into a "mature" NIS differs, mainly by presenting five characteristics related to the external relationship (ER), governance (GO) and strategy (ST). Initially, it presents a great diversity of public and private actors: trade unions, research laboratories, large and small companies, universities and government entities (ER). The relationship between those actors is close due to the active and systematic promotion (internal and external) of events, cooperative projects and working groups (ER). In addition, the entity members are more involved in the governance structure (board of directors), that generates more transparency and commitment (GO). Finally, all activities of the environment are developed in line with the national innovation policy, in other words, with the NIS (ST).

Secondly, all of these characteristics have a positive influence on the key components of the NIS: variety of the agents, degree of internal and external interaction of the environment, and institutions or relationship rules. The environment positioned in the "mature" NIS presents a set of characteristics, which are more developed for the innovation, confirming the initial premise of this work. In summary, "mature" NISs create knowledge by the intense interaction between a diversity of actors with multidisciplinary bases of knowledge, in a structured and united way and in line with a macro strategy of the system.

It is important to point out some limitations of this study. First of all, the conclusions reflect the specific reality of the two innovation environments studied. This could therefore vary if other environments of the two countries were studied, with a longer "life time" for example. Thus, they cannot be generalized indiscriminately. Another limitation refers to the fact that there are good practices in the Brazilian innovation environment studied. This means that there are improvement actions that can be suggested to the French environments, but that were not done in this study. A third consideration is that some of the actions proposed as an improvement have implementation barriers, since they depend on the national structure and context, not analyzed in this study.

Finally, some suggestions for the future work can be pointed out. Firstly, a research line would be to confirm the differentiated characteristics of the environments located in "mature" NISs, by case studies in a larger number of innovation environments in the same countries studied in this research. Another relevant aspect of research would be to quantitatively analyze the influence of the characteristics of innovation environments in the maturity of NISs, that is, which characteristics of the environments have a bigger impact on their maturity.

REFERENCES

ALBUQUERQUE, E. M. National Systems of Innovation and Non-OECD Countries: Notes about a Rudimentary and Tentative "Typology." **Brazilian Journal of Political Economy**, v. 19, n. 4, p. 35–52, 1999.

ALBUQUERQUE, E.M.; BAESSA, A. R.; KIRDEIKAS, J. C. V. Produção Científica e Tecnológica das Regiões Metropolitanas Brasileiras. **Revista Economia Contemporânea,** v. 9, n. 3, p. 615–642, 2005.

ARBIX, G. Inovação: estratégia de sete países. **Agência Brasileira Desenvolvimento Industrial**, v. 15, p. 342, 2010.

EDQUIST, C. The Systems of Innovation Approach and Innovation Policy: An account of the state of the art. In **DRUID Conference,** 2001.

EDQUIST, C. Reflections on the systems of innovation approach. **Science and Public Policy,** v. 31, n. 6, p. 485–489, 2004.

FIGLIOLI, A. **Perspectivas de Financiamento de Parques Tecnológicos: um estudo comparativo**. Universidade de São Paulo, 2007.

FILHO, C. D.; GONÇALVES, C. A.; PARDINI, D. J. O impacto na inovação e da gestão do conhecimento de marketing no desempenho de novos produtos no mercado. **Revista de Administração E Inovação,** v. 5, n. 2, p. 5–24, 2008.

FREEMAN, C. The National System of Innovation in Historical Perspective. **Cambridge Journal of Economics,** v. 19, n. 1, p. 5–24, 1995.

GANGA, G. M. D. **Trabalho de Conclusão de Curso (TCC) na engenharia de produção: um guia prático de conteúdo e forma.** Sao Paulo: Atlas, 2012.

GARGIONE, L. A. **Um modelo para financiamento de parques tecnológicos no Brasil: explorando o potencial dos fundos de investimento.** Universidade de São Paulo, 2011.

LES PÔLES DE COMPÉTITIVITÉ. (n.d.). Politique des Pôles : Qu'est-ce que'un pôle de compétitivité? Retrieved November 23, 2013, from http://competitivite.gouv.fr/politique-des-poles-471.html

NELSON, R. **National innovation systems: a comparative analysis**. New York, Oxford: Oxford University, 1993.

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT. **Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data** (3rd Editio.). OECD Publishing, 2005.

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT. **Relatório Territorial da OCDE: Brasil,** 2013.

SILVA, D. D. **Articulação do sistema de inovação no município de Sorocaba. Um estudo com base na experiência nacional de ambientes de inovação e nos pólos franceses de competitividade.** Universidade de São Paulo, 2009.

SOUZA, N.J. Teoria dos pólos, regiões inteligentes e sistemas regionais de inovação. **Análise,** v.16, n.1, p. 87-112, 2005.

TURRIONI, J. B.; MELLO, C. H. P. **Metodologia de pesquisa em engenharia de produção: estratégias, métodos e técnicas para a condução de pesquisas quantitativas e qualitativas**. Programa de Pós-graduação em Engenharia de Produção, Universidade Federal de Itajubá, 2012.

YIN, R. K. **Estudo de caso: planejamento e métodos.** Porto Alegre: Bookman, 2015.

ZOUAIN, D. M. **Parques tecnológicos: propondo um modelo conceitual para regiões urbanas - o parque tecnológico de São Paulo**. Universidade de São Paulo, 2003.