Journal of Business and Economics, ISSN 2155-7950, USA
January 2019, Volume 10, No. 1, pp. 50-67
DOI: 10.15341/jbe(2155-7950)/01.10.2019/005

http://www.academicstar.us

Success Factors and Boundary Conditions for Technology Parks in the Light of the Triple Helix Model

Adriana Ferreira de Faria[1], Juliane de Almeida Ribeiro[2], Marcelo Gonçalves do Amaral[3,4], Jaqueline Akemi Suzuki Sedyama[1]

(1. Department of Production and Mechanical Engineering (DEP), Federal University of Viçosa, Brazil;

2. Federal Institute of Education, Science and Technology of Minas Gerais, Campus Ouro Branco, Brazil;

3. Triple Helix Research Group, Brazil; 4. Fluminense Federal University, Brazil)

Abstract: The innovation environments known as technology parks represent a worldwide phenomenon as agents of promotion of scientific and technological development and consequently of economic and social development. Despite different typologies, legal models and governance, there is a consensus in the literature and with managers that the first and noblest function of a technology park is to induce economic development, through technological innovation achieved through the interaction between companies and knowledge-generating institutions. It is also known the complexity of the management and operation of a technology park, involving several stakeholders with different interests and objectives and requiring high financial investments. Given this framework, the question is how to establish technology parks so that these are successful enterprises and development promoters? In this context, this work aimed to present a conceptual model on the management of technology parks that considers the relationships of the concepts of the Triple Helix with the main factors of success and boundary conditions that can influence its performance. It was a methodological approach understood by the theoretical framework and case study. The analysis of critical success factors and boundary conditions is related as prerequisites or parameters for the viability of these environments. The case study was conducted at the Centennial Campus, *University Research Park* of *North Carolina State University* (*NC State*), one of the most prominent science parks in the United States.

Key words: triple helix model; technology parks; boundary conditions

JEL codes: O

Adriana Ferreira de Faria, D.Sc. Mechanical Engineering, Professor, Department of Production and Mechanical Engineering (DEP), Federal University of Viçosa; research areas/interests: innovation management, innovation environments, product development process. E-mail: adrianaf@ufv.br.

Juliane de Almeida Ribeiro, Ph.D. in Administration, Professor, Federal Institute of Education, Science and Technology of Minas Gerais, Campus Ouro Branco; research areas/interests: marketing, entrepreneurship, innovation. E-mail: juliane.ribeiro@ifmg.edu.br.

Marcelo Gonçalves do Amaral, D.Sc. Industrial Engineering, Professor, Triple Helix Research Group, Fluminense Federal University; research areas/interests: innovation management, strategy, entrepreneurship. E-mail: marcelomaral@id.uff.br.

Jaqueline Akemi Suzuki Sedyama, Master in Administration, Professor, Department of Production and Mechanical Engineering (DEP), Federal University of Viçosa; research areas/interests: economic engineering, innovation management. E-mail: jaqueline.suzuki@ufv.br.

1. Introduction

The economic development of regions and countries is increasingly linked to the valorization of science and technology activities (National Academy of Sciences, 2010), since in the knowledge society, technological innovation plays a decisive role in the search for and sustainability of competitive advantages of companies and economic sectors (Chaia & Shihb, 2016). Entrepreneurship and innovation are increasingly strategic themes (Barr, Baker, Markham, & Kingon, 2009) since the dynamics of technological innovation (Senge & Goran Carstedt, 2001) is linked to systemic processes of generation and transfer of knowledge, associated with university-business-government interaction (Etzkowitz H., 2009).

Successful international experiences demonstrate that the promotion of sustainable development relies heavily on the coordinated efforts of various actors involved in the innovation process (Etzkowitz H., 2003a). In this context, the approach proposed by the model known as the Triple Helix (Etzkowitz & Leydesdorff, 2000) is internationally accepted as the most complete and current, being a mandatory conceptual reference, either in the practical applications of the proposed principles or in the critical reflections on the theme. The entrepreneurial universities (Etzkowitz H., 2003b) play a key role in the Triple Helix Model.

The most recent work on Triple Helix has focused on the study of intermediary organizations (Bellgardt, Gohlke, Haase, Parzonka, & Schicketanz, 2014), which can be understood as a hybrid organization (Etzkowitz H., 2003a), formed endogenously by the institutional overlap between the three spheres of the Triple Helix, strongly influencing the university-business-government relationship (Johnson, 2008). Intermediary organizations can be foundations, associations, consortia, research centers and scientific and technological parks, with unique characteristics and therefore should be explored independently (Metcalfe, 2010).

Intermediary organizations or innovation environments known as science parks, or science parks or university parks, represent a worldwide phenomenon (Siegel, Westhead, & Wright, 2003b). They are seen as agents of promotion of scientific and technological development (Link, 2014) and consequently of economic and social development (Jongwanich, Kohpaiboon, & Yang, 2014). Given this framework, the question is how to plan, implement and operate technology parks so that these are successful enterprises capable of promoting economic development?

Thus, this work aims to present a theoretical conceptual reference model on the management of technology parks that considers the relationships of the concepts of the Triple Propeller with the main factors of success and boundary conditions that can influence its performance. The analysis of critical success factors and boundary conditions are related as prerequisites or parameters for the viability of these environments as organizations that help promote innovation and development. Due to the complex nature of the studied phenomenon, a methodological approach was used, understood by the theoretical reference and case study. The case study was conducted at the *Centennial Campus*, *university research park* of *North Caroline State University* (NC State). The work is organized in theoretical framework, methodology and results and discussions.

2. Theoretical Background

2.1 Interaction University-Industry-Government According to the Triple Helix

Linking economic development to innovation has been an issue for more than 60 years (Schumpeter, 1961). Unfortunately, relations between academic institutions and companies are still very fragile (Etzkowitz H. , 2003a),

jeopardizing the consolidation of the innovation process and, consequently, the desired economic and social development (CDTR & MCTI, 2014). It is common sense that there is still a gap between science and the market, also known as in the world literature as "death valley" (Barr, Baker, Markham, & Kingon, 2009). Adding values to products, processes and services is essential to achieving global competitiveness with sustainable development.

Given the increasing difficulties associated with the production of wealth from commodities and low technology products, technology-based enterprises (European Commission, 2007) have emerged as a valuable alternative for economic and social development. Thus, university-business-government interaction is increasingly becoming one of the keys to development in a knowledge-based economy (Etzkowitz H., 2009). In fact, seeking to follow this trend, governments in several countries (Bakouros, Mardas, & Varsakelis, 2002; Siegel, Westhead, & Wright, 2003b; Link & Scott, 2006; Bigliardi et al., 2006; Fukugawa, 2006; Anprotec & ABDI, 2008; Kharabsheh, 2012; Jongwanich, Kohpaiboon, & Yang, 2014; Jia, Gao , & Cao, 2015) are making efforts to promote the development of their national innovation systems in recent years.

Among the main actions, we can mention the creation of policies to stimulate the Triple Helix (Etzkowitz & Leydesdorff, 2000), the technological innovation (Cantisani, 2006), the creation of technology-based companies (Ferguson & Olofsson, 2004; Etzkowitz H., 2003b), the investment in research and development (P&D) and innovation environments, made up of, among other things, science and technology parks and business incubators (Siegel, Westhead, & Wright, 2003a; Etzkowitz H., 2003a; Phan, Siegel, & Wright, 2005; Tsamis, 2009).

The model of university-industry-government interaction for innovation, according to the Triple Helix, is analytically different from the traditional approach of national innovation systems (Etzkowitz & Leydesdorff, 2000), which considers that the company has the leading role in innovation (Laissez-faire) or from the model in which the State is the inducing agent of this process ("Sabato Triangle"), according to Figure 1.

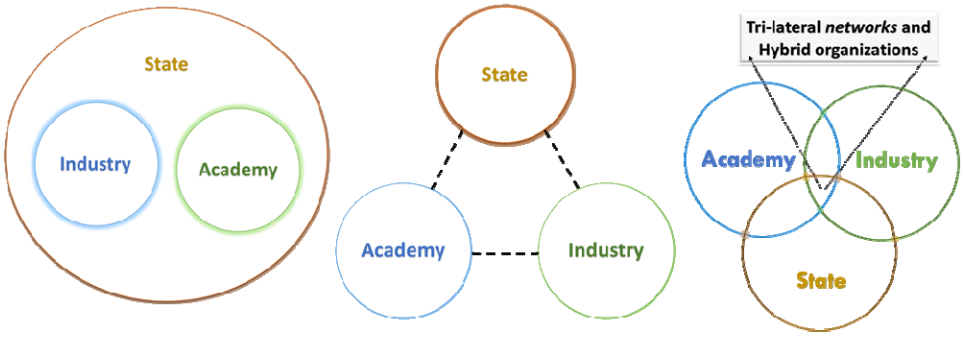

Figure 1 From the View of the Sabato Triangle and Laissez-faire for the Triple Propeller Model (Etzkowitz & Leydesdorff, 2000).

The boundaries between the public and private, science and technology, and university and industry are in flux and these organizations are assuming, more and more tasks that were before on the other, and in this context university-industry-government relations can be considered as a triple propeller of evolving communication networks (Leydesdorff, 2000). Obviously, triple-helix interactions are more complex than double-helix interactions between the actors that make up the model (Metcalfe, 2010).

In contrast to the traditional National Innovation System, in which each institution operates along a single axis, in the Triple Helix institutions operate on two axes, an "x" axis, in which they play their traditional roles, and a "y", in which they play new roles (Ivanova & Leydesdorff, 2014). Thus, a key feature of the Triple Helix is that

the model incorporates both old and new roles as well as the relationships between the institutional spheres of the university, industry and government (Etzkowitz H., 2009; Etzkowitz H., 2003a). In most institutional models, each institution performs a single task, according to its defined mission. Therefore, the basic thesis of the Triple Helix is that it is possible for an institutional sphere to play multiple roles without its original role being degraded or impaired. A specific corollary of this thesis is that the secondary functions performed by a sphere are the main functions of the other spirals of the Triple Helix (Etzkowitz & Leydesdorff, 2000).

The second essential feature of the Triple Helix model is the valued and strategic importance of the university's role (Etzkowitz & Leydesdorff, 2000; Etzkowitz H., 2003a; Ivanova & Leydesdorff, 2014). Entrepreneurial universities (Etzkowitz H., 2003b) play a key role in the Triple Helix through the transfer of technology, the creation of companies and the conduction of regional renewal efforts. Entrepreneurial universities strive to use the knowledge they generate in promoting social and economic development, and therefore in the Triple Helix model they are considered as primary institutions of great importance (Bellgardt, Gohlke, Haase, Parzonka, & Schicketanz, 2014) in contrast to previous views of university-industry-government interaction.

The value of technological innovation is indisputable (Vilà & Pagès, 2008; Pisano G., 2006; National Academy of Sciences, 2010). Thus, part of the entrepreneurial activity is based on the expectations that the use of the research will stimulate new ideas and income, is the so-called "knowledge capitalization" (Etzkowitz H., 2003b). The emergence and growth of new companies from academic research and the location of technology-based companies in the vicinity of universities (Ferguson & Olofsson, 2004) are manifestations of the relations of the Triple Helix in the knowledge society (Hansson, Husted , & Vestergaard, 2005).

A Triple Helix type scheme usually begins with the reciprocal interaction between university, industry and government so that one helps improve the performance of the other, where collaboration occurs through its traditional roles involved in innovation (Etzkowitz H., 2009). Four phases can be identified in the development of Triple Helix (Etzkowitz H., 2003a): internal transformation of each of the helix; influence of one helix on the other; creation of a new overlap of trilateral networks and organizations of the interaction between the three helix, as shown in Figure 1; a recursive effect of networks and partnerships of the Triple Helix, both on the helix from which they arose, but also on society in general.

At the initial level of Triple Helix (Johnson, 2008), organizations begin to interact to improve the local economy. For example (Etzkowitz H., 2003a), universities, companies and governments in a region can participate in discussions to improve the local economy, develop a regional growth agreement or establish a technology council. In a second moment of the development of the Triple Helix, in addition to performing its traditional tasks, each helix partner "assumes the role of the other" (Etzkowitz & Leydesdorff, 2000), this does not mean that university and government, for example, become companies and vice versa.

The intersection of the Triple Helix, with relatively independent institutional spheres, can generate hybrid organizations (Etzkowitz H., 2003a). For this, some universities have been implementing internal institutional bodies to support technological innovation. This is the case of Technology Transfer Offices, designed to help protect the knowledge generated in the academy; of business incubators, which provide physical and managerial infrastructure support in the first years of life of technology-based nascent companies; and technology parks, which are conducive to development by attracting and supporting technology-based companies.

In the intersection of the spheres between the actors, what was before competition and cooperation becomes "co-opetition" (Bellgardt, Gohlke, Haase, Parzonka, & Schicketanz, 2014). Thus, the most recent work on Triple Helix has focused on the study of intermediary organizations (Johnson, 2008; Metcalfe, 2010; Ivanova &

Leydesdorff, 2014; Bellgardt, Gohlke, Haase, Parzonka, & Schicketanz, 2014; Jongwanich, Kohpaiboon, & Yang, 2014) which can be understood as a hybrid organization (Etzkowitz & Leydesdorff, 2000; Etzkowitz H., 2003a; Etzkowitz H., 2003b) formed endogenously by the institutional overlap between the three spheres of the Triple Helix, strongly influencing the university-business-government relationship.

Intermediary organizations can be foundations, associations, consortia, research centers and scientific and technological parks, with unique characteristics and therefore should be explored independently (Metcalfe, 2010). A model of technology park may represent ternary models of university-business-government relationship, such as the Triple Helix (Zouain & Plonsky, 2006).

2.2 Technology Parks

Despite different typologies, legal models and mechanisms of governance (Angle Technology, 2003), there is a consensus in the international literature and with the managers that the first and noblest function of a technology park is to induce economic development (Siegel, Westhead, & Wright, 2003a; European Comission, 2007; Hansson, Husted, & Vestergaard, 2005; Monck & Peters, 2009; Dabrowska, 2011; Minguillo, Tijssen , & Thelwall, 2015), through the technological innovation achieved by the interaction between companies and institutions that generate knowledge (Siegel, Westhead, & Wright, 2003b; Link & Scott, 2003; Link, 2014; National Academy of Sciences, 2009). It is difficult to formulate a conceptual framework for technology park, which is fully consensual (Link & Scott, 2003; Hansson, Husted, & Vestergaard, 2005). There are several typologies proposed in the literature and all may be useful depending on the object of analysis, as shown in Table 1.

Table 1 Definitions of Technology Park

IASP[1]	Areas of Innovation and Science, Technology and Science Parks are: highly specialized organizations, through a dynamic and innovative mix of policies, programs, quality space and resources and services with high added value. They stimulate and manage the flow of knowledge and technology between universities and companies; facilitate communication between companies, entrepreneurs and technicians; provide environments that enhance a culture of innovation, creativity and quality; have a focus on companies and research institutions, as well as on people — entrepreneurs and knowledge workers; facilitate the creation of new enterprises through incubation and spin-off mechanisms, and accelerate the growth of small and medium-sized enterprises; work in a global network that brings together thousands of innovative companies and research institutions around the world, facilitating the internationalization of their resident companies.
AURP[2]	A university research campus (*university research campus*) is a venture that has a master plan, research and marketing project, creates partnerships with universities and research institutions, encourages the growth of new companies, gives meaning to technology, and directs economic development based on technology.
ANPROTEC[3]	Technology park is defined as a complex industrial and scientific-technological basis, planned, formal, concentrated and cooperative, which aggregates companies whose production is based on technological research developed in R & D centers linked to the park. It is an enterprise that promotes the culture of innovation, competitiveness, increased business capacity building, based on the transfer of knowledge and technology, with the aim of increasing the wealth production of a region

According to the Brazilian Agency for Industrial Development (ABDI) and Anprotec, the Technology Parks of the future, should (Anprotec & ABDI, 2008): present a clear and objective value proposal that makes the venture unique; promote scientific and technological development in priority areas for the country; be connected to entrepreneurial universities and excellence; have an implementation plan and a management system that allows

[1] International Association of Scientific Parks and Areas of Innovation (IASP), accessed on 3 Feb. 2015, available online at: http://www.iasp.ws/the-role-of-stps-and-innovation-areas.

[2] Association of University Research Parks (AURP), accessed on 3 Feb. 2015, available online at: http://www.aurp.net/what-is-a-research-park.

[3] Associação Nacional de Entidades Promotoras de Empreendimentos Inovadores (ANPROTEC), accessed on 3 Feb. 2015, available online at: http://www.anprotec.org.br.

the construction of strong, winning and inspiring brands; to have anchor projects of science, technology and innovation that allow to establish a qualified technological base and instruments of articulation and mobilization of the companies; to develop a viability model.

Despite the potential benefits and value of science and technology parks (National Academy of Sciences, 2009), there has been a lack of more robust performance evaluation systems in recent years that are capable of proving results, indicating opportunities for improvement and sustain the effectiveness of parks as an instrument of public policy (Phan, Siegel, & Wright, 2005; Vedovello C., 1997; Vedovello, Judice, & Maculan, 2006; Bigliardi et al., 2006; Monck & Peters, 2009; Dabrowska, 2011; MCTI, 2015).

The literature has proposed that a rational way to evaluate the performance of technology parks is to compare the performance of companies inside and outside this environment (Löfsten & Lindelöf, 2002). These studies seek to assess whether there are significant statistical differences between companies, in some performance indicators such as number of jobs, turnover, innovation and R & D and company survival rate. In this context, several recent studies have concluded that parks tend to fail to attract and develop high-tech enterprises and therefore failed to fulfill their expected role as catalysts of regional economic growth (Hansson, Husted, & Vestergaard, 2005; Vedovello C., 1997; Westhead, 1997; Bakouros, Mardas, & Varsakelis, 2002).

The results of the researches on the importance of the technology parks on the improvement of the performance of the resident companies (Löfsten & Lindelöf, 2002; Siegel, Westhead, & Wright, 2003a; Siegel, Westhead, & Wright, 2003b) and the relationships between companies and universities (Link & Scott, 2003; Siegel, Waldman, & Link, 2003; Vedovello C., 1997) are not conclusive (Schmidt & Balestrin, 2015; Helmers, 2011; Dabrowska, 2011; Monck & Peters, 2009; Bakouros, Mardas, & Varsakelis, 2002). On the other hand, it is argued that the comparative studies between the performance of resident companies and non-resident companies in parks do not provide a complete view of the value that parks add, even because parks do not only have technology-based companies as residents (Hansson, Husted, & Vestergaard, 2005).

It should also be considered that these results are difficult to generalize, since they are mostly case studies for a technological park or for a region, with many dependent variables involved, such as the maturity and objectives of the park analyzed, the nature of the stakeholders involved, the geographical location and the level of regional development. Additionally, it is understood that the concept of success or failure is relative, and must be evaluated according to established goals and objectives. Assessing a technology park in relation to its short- and long-term goals can give a clear picture of its position and its progress toward sustainability (Wasim, 2014).

Another difficulty associated with the generalization of the performance evaluation results of technology parks is associated to the fact that the park has several stakeholders (Chiochetta, 2010), with different institutional missions. Technology parks “serve many masters with different interests and expectations” (Hansson, Husted, & Vestergaard, 2005) and managing all those interests is a complex task (Júnior, Porto, Pacífico, & Júnior, 2015).

However, there is still no consensus on what is a successful technology park and lack common evaluation metrics that allow the comparison of different parks in a systematic way (Dabrowska, 2011). There is no adequate systematic framework for understanding the dynamic nature of parks and their resident companies, as well as a lack of clarity in understanding the nature of park performance (Phan, Siegel, & Wright, 2005).

Technology parks have generated not only benefits in the form of new entrepreneurial ventures, the generation of highly qualified jobs and local and regional development (CDTI and MCTI, 2014; Fundação Certi, 2013; MCT, 20015), as well as synergies from the Triple Helix (Jongwanich, Kohpaiboon, & Yang, 2014) which involve the resources and efforts of governments, universities, research institutions and private initiative

(Ndonzuau, Pirnay, & Surlemont, 2001). In this way, it is fundamental to understand the aspects that can favor the planning, management and operation of technology parks, in order to promote their performance and success.

Although the definition of science and technology parks may emphasize different aspects, some elements seem to emerge as common denominators for most of these ventures (Bellavista & Sanz, 2009): management of the environment and services that stimulate the transfer of technology among the various actors involved; effective relationship with universities; offering value-added services; support facilities such as living spaces, residential areas and leisure facilities; mechanisms for the creation of technology-based companies; mechanisms for attracting consolidated companies; development of networks and networking, beyond its borders.

In a study conducted by the Association of University Research Parks (AURP, 2013), six critical success factors of a park were listed: good convergence between the scientific base of affiliated university and resident companies; ability to assist nascent businesses in marketing processes; access of resident companies to investment capital; priority in providing spaces for companies graduated from the incubator; priority access to the resources of the university(ies), such as facilities, researchers and students; presence of an incubator. When analyzing the literature, other factors can be considered for the success of the technology park, as presented in Table 2.

Table 2 Success Factors of Technology Parks

Governance	Phan, Siegel, & Wright, 2005; Júnior, Porto, Pacífico, & Júnior, 2015; Chiochetta, 2010; Kharabsheh, Magableh, & Arabiyat, 2011.
Geographic location	Vedovello C., 1997; Link & Scott, 2003; Angle Technology, 2003; Parry, 2006
Infrastructure	Gargione, Plonski, & Lourenção, 2005; Vedovello, Judice, & Maculan, 2006; Parry, 2006; Angle Technology, 2003; AURP, 2013.
Capacity for innovation and entrepreneurial culture of the region	European Comission, 2007; Kharabsheh, 2012; Parry, 2006.
Qualified management team	Kharabsheh, Magableh, & Arabiyat, 2011; Kharabsheh, 2012; Parry, 2006; AURP, 2013
Offering services to businesses and partners	Angle Technology, 2003; European Comission, 2007; Gargione, Plonski, & Lourenção, 2005; Parry, 2006; Johnson, 2008; Kharabsheh, Magableh, & Arabiyat, 2011; AURP, 2013.
Presence of anchor company	Parry, 2006; Wasim, 2014.
Network for learning	Hansson, Husted, & Vestergaard, 2005; Parry, 2006.

It is also possible to highlight a set of external aspects to the park related to cultural, political, economic and social issues (Parry, 2006). This environmental factor (*environment*) influences the degree of development and the viability of parks, and their interference can be seen in the definition of priorities, in the institutional structure in relation to technology transfer, in cooperation and entrepreneurship, in the availability of resources to attract companies to the park and in the domestic market that supports the growth of small technology-based firms (Tsamis, 2009; Parry, 2006; AURP, 2013).

3. Methodology

This is a theoretical conceptual work (Coughlan & Coghlan, 2002; Cooper & Schindler, 2003; Mello, Turrioni, Xavier, & Campos, 2012), that due to the complex nature of the phenomenon studied, a methodological approach will be used, understood by the theoretical reference and case study (YIN, 2005; MIGUEL, 2007). This research can also be characterized as exploratory and qualitative (Cooper & Schindler, 2003). Exploratory research is developed with the aim of providing an overview of a given fact (Gil, 2006; VERGARA, 2005), helping in the construction of hypotheses. The exploratory researches seek to provide clarification and

understanding of the nature of the problem, being adequate to discover factors not structured by managers in processes, ideas and data (Mello, Turrioni, Xavier, & Campos, 2012). But the qualitative nature of the study is due to the emphasis given to the processes and meanings related to the understanding of the management of technology parks and the Triple Helix.

For the present theoretical study, with regard to technology parks, the analysis of critical success factors and boundary conditions is related as a prerequisite or parameter for the viability of these environments as organizations that help to promote innovation and development. With regard to the Triple Helix, the analysis focused on promoting innovation through university-industry-government relationship and the role of intermediary organizations, particularly scientific and technology parks. The case study was carried out at the *Centennial Campus*, where it was sought to analyze the governance and management mechanisms used by the *Centennial Campus* as a research park and how it behaves as an intermediary organization.

4. Results and Discussions

4.1 Case Study: Centennial Campus

The case study was conducted at the *Centennial Campus*, *University Research Park*, *North Carolina State University* (NC State), in Raleigh, USA, in the vicinity of *Research Triangle Park* (RTP), and is therefore part of the region. The *Centennial Campus* is considered by AURP one of the most important science parks in the USA and is therefore chosen as an "exemplary case". In order to analyze and understand the success factors of the *Centennial Campus*, which would validate the reference model for the management and planning of technology parks, we sought from the first moment the integration with the park management team.

NC State was founded in 1887, being one of the best universities in the USA[4] and one of the largest in the State of North Carolina[5], with more than 34,000 undergraduate and graduate students. The Institution has 2,300 teachers and researchers and an annual research budget of more than 400 million dollars[6]. The university offers more than 300 undergraduate and postgraduate courses in 65 departments[7]. Throughout its history, *NC State* has combined scientific breakthroughs with economic development opportunities, creating more than 400 new products, 100 startups, 8.100 new jobs, 3.100 new inventions (*disclosure process*), 850 patents registered in the US and US $ 1.6 billion in funding[8]. Their startups represent an additional US$ 1.5 billion in venture capital investments and 3.100 jobs[9].

In 1997, the institution, on its 100th anniversary, set up its new campus, the *Centennial Campus*, which would bring students, teachers, researchers, businesses, government agents and non-governmental organizations together into the same environment, becoming one of the major research parks in the USA. The *Centennial Campus* is a university research park (*university research park*[10]) which has been built according to the concept of "living, working, having fun and learning" (*Live, Work, Play and Learn*), according to its Strategic Plan.

The *Centennial Campus* numbers, in 2014, illustrate its importance and scope: 372,000 square meters of

[4] Available online at: http://www.kiplinger.com/tool/college/T014-S001-kiplinger-s-best-values-in-public-colleges/index.php?id=7794, accessed on 25 Sep. 2015.
[5] Available online at: https://www.ncsu.edu/about/history-and-tradition/, accessed on 28 Sep. 2015.
[6] Available online at: http://licensing.research.ncsu.edu/, Accessed on 28 Sep. 2015.
[7] Available online at: https://www.ncsu.edu/academics/departments-a-z/, accessed on 28 Sep. 2015.
[8] Available online at: https://research.ncsu.edu/our-office/rankings/, accessed on 28 Sep. 2015.
[9] Available online at: http://research.ncsu.edu/our-office/, accessed on 28 Sep. 2015.
[10] Available online at: http://www.aurp.net/what-is-a-research-park, accessed on 11 Sep. 2015.

space constructed in more than 45 buildings; $ 1 billion in infrastructure investments; 72 companies, government agencies, and nonprofit resident organizations; more than 75 *NC State* research centers, institutes, laboratories, and departmental units; 2,760 employees linked to resident organizations; 62 housing units; and 292 apartments and houses for 1,200 students. More than 11,000 people circulate daily at the *Centennial Campus* during the school year. After almost 30 years, the *Centennial Campus* is practically a "self-sustaining city". But it is important to consider that much of the development (60%) has occurred recently, between the years 2009-2014.

The Office of Partnerships and Economic Development (*Office of Partnerships and Economic Development* — OPED) is responsible for managing relations between companies, *NC State* and the government, therefore the *Centennial Campus* as a research park. The OPED belongs to the organizational structure of the *NC State* Office of Research, Innovation and Economic Development (*Office of Research, Innovation and Economic Development* — ORIED) which is composed of the following units:

- Office of Partnerships and Economic Development (Office of Partnerships and Economic Development — OPED).
- Office of Technology Transfer (Office of Technology Transfer — OTT).
- Research Development Office (Research Development Office — RDO).
- Integrated Support Services Centers (Integrated Support Service Center — ISSC).
- Compliance and Regulation Services (Sponsored Programs & Regulatory Compliance Services — SPARCS).
- Research Centers and Institutes.

The OPED has the vision that the university should play a critical role in economic development, preparing students for the job market, promoting scientific discovery that translates into economic growth, and working with new and existing companies. Its main activities are organized in three axes:

- Build mutually beneficial relationships between university, industry, government agencies and non-profit organizations.
- Streamline access to important resources to help partners and potential partners who want to work with the university.
- Advice businesses and other organizations interested in relocating to North Carolina, including the *Centennial Campus*, or developing projects in the region.

The organizational structure of OPED is composed of the following units:

- Partnerships Office: Centennial Campus' Partnership Office e Industry Alliances
- Strategic Projects Office
- Economic Development Office
- Marketing and Communication

The Partnerships Office seeks to assist the innovation process of companies by facilitating their access to researchers, students, laboratories, education and technologies belonging to *NC State*. The central objective is related to the establishment of collaboration, research and innovation projects between industry and the university that promote innovation and development. The Partnerships Office has its activities organized in two main axes:

- Alliances with Industry (*Industry Alliances*) — development of research projects and partnerships between *NC State* and industries, whether or not resident in *Centennial Campus*.
- Partnerships with the *Centennial Campus* (*Centennial Campus' Partnership Office*) — services to organizations resident in the *Centennial Campus*.

The Office for Economic Development works in collaboration with various partners (NC Department of Commerce, Research Triangle Regional Partnership, Research Triangle Foundation, Wake County Economic Development, Raleigh Economic Development) to promote economic growth and job creation for the region.

The main condition for a company or organization to settle in the *Centennial Campus* is to develop collaborative projects with *NC State*. In this sense, the main service offered by OPED is to help companies to establish these partnership projects, on an ongoing basis. The other services offered to companies and resident organizations of the *Centennial Campus* are in partnership with OTT and SBTDC. The OPED also supports the development of *NC State* Incubator activities, located at the *Centennial Campus*. The Incubator provides support to entrepreneurs and technology-based start-ups by facilitating access to *NC State* resources, qualification of entrepreneurs, and business development advisories.

Other universities and research parks also have the actors, services or elements present at the *Centennial Campus*, such as liaison office for university-business interaction, technology transfer office, business incubator, and business service structures. What makes the *Centennial Campus* differentiated is the interaction between these elements, constituted in an ecosystem of innovation, called the *Springboard Innovation Hub* (Faria & Kekas, 2016).

The *Springboard Innovation Hub* brings together, in a single differentiated location, "under one roof", in the "heart" of the *Centennial Campus*, according to the "*one-stop-shopping*" concept, all units and services of ORIED. The *Springboard Innovation Hub* is a collaborative environment that "sparkles" innovative thinking, offers a distinctive way to more easily connect people, ideas, and resources to developing relationships, partnerships, projects, innovation and business. By integrating work among its different stakeholders, the *Springboard Innovation Hub* offers solutions for new business development, technology transfer and the establishment of collaborative projects. In addition to services, this environment still provides shared business physical infrastructure to partners.

The case study points out that the *Centennial Campus* has four important differentials: governance (led by ORIED); Springboard Innovation Hub, built according to the concept of "dynamic collaborative work"; the planning and design of the campus deployed from the concept "live, work, play and learn"; and the excellence of NC State, the park's great anchor. The Centennial Campus demonstrates that with appropriate governance and geographic proximity between university and industry it is possible to strengthen the bonds between industry, university and government partners such as the Triple Helix Model, achieving significant results for society.

4.2 Conceptual Theoretical Model for the Management of the Technology Park

The conceptual basis proposed here is based on the Triple Helix Model (Etzkowitz & Leydesdorff, 2000) and in the success factors for the management of technology parks, according to Theoretical Framework. Dessa forma, para o desenvolvimento do modelo serão consideradas quatro dimensões de gestão, sendo três construídas à luz dos princípios da Hélice Tríplice, e uma referente aos processos internos do parque, a saber:

- Dimension of technical and scientific management - contemplates the relationship with the university and the research institutions that generate knowledge, raw material for innovation. It is an external perspective of performance, which reflects how much the park can influence through the promotion and strengthening of the university-enterprise relationship, scientific and technological development.
- Dimension of business management — represents the relationship with companies. It is an external perspective of performance that reflects the conditions that the park must offer companies to assist them in promoting innovation and increasing competitiveness.

- Dimension of sustainable development — contemplates the relationship with the sphere of government and society. It is an external perspective of performance, which reflects the value of the park by society and stakeholders, depending on the contribution of the park to the economic and social development of the region.
- Dimension of internal processes — represents the conditions related to the internal processes of the park that offer services and value, which impact the culture of innovation and entrepreneurship and the relationship networks of the park. It is an internal perspective of performance, which depends on the planning and maturity of the park, but also considers the conditions surrounding the environment and the local intellectual capital, under which the park can have influence and that in a systemic way can impact its success and performance of enterprises.

The technical and scientific dimension impacts the business dimension, which together impact the sustainable development dimension. On the other hand, unfolding in the opposite direction is also true. The conditions offered by the region in relation to the culture of entrepreneurship and innovation will also impact the business environment for the companies of the park, as well as the relation of this with the institutions that generate knowledge. Obviously, the government, through the establishment of policies and adequate financing, will impact all other dimensions.

In order for these dimensions not to be static and to relate to and develop in the Triple Helix view, the technology park, as an intermediary organization, will have to develop a propitious environment with a portfolio of services, activities, practices, actions and facilities that place the "helix in motion". The technology park should promote the relationship between the helix spheres, but should also develop conditions for these entities to play each other's role, while retaining their original missions and functions independently, but aligned around the objectives of the park.

The *Centennial Campus* case, on the other hand, indicates that the results are satisfactorily achieved over time as the relationship process between university-industry-government actors matures, as well as the very nature of governance and technology park services. This finding is conceptually illustrated in Figure 2. The technology park represents the helix (or a motor) that causes the Triple Helix to rotate.

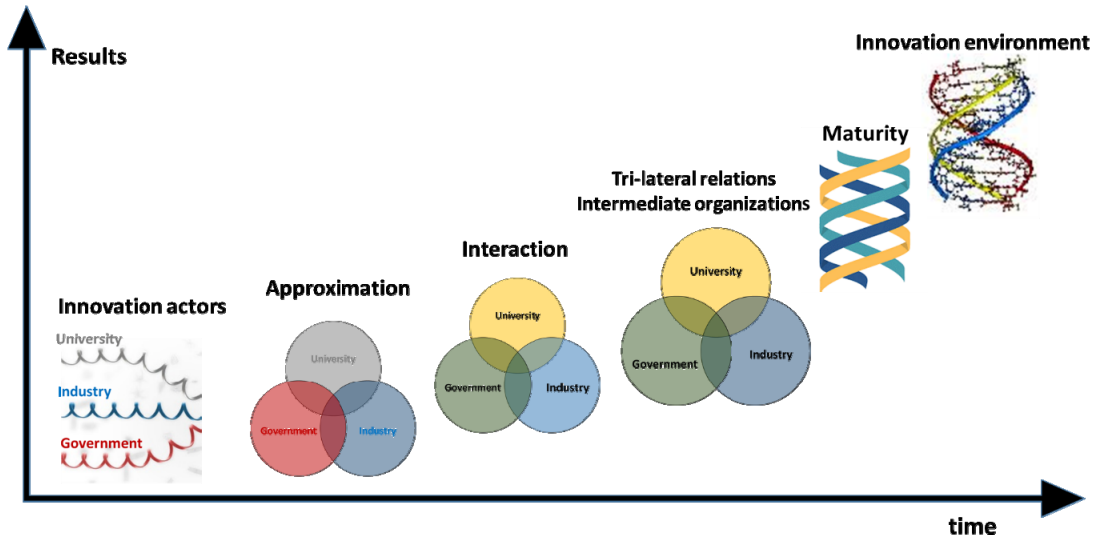

Figure 2 Conceptual View of Maturity of the Triple Helix and the Role of An Intermediary Organization Over Time, Proposed by the Authors

The management of a successful technology park, which may justify the investment of the enterprise, must take into account the key factors for the success and the boundary conditions in which the park is submitted, in order to guarantee the necessary bases for the proper development of the ecosystem desired innovation. The boundary conditions and success factors are elements that the technological park will have access, usually defined by the vocations and potentialities of the region, and which reflect in the viability or not of the enterprise, but also elements that the park makes feasible, through a planning adequate and available resources.

According to the experience of the Centennial Campus, technology parks must be privileged places of innovation, business, networking and transfer of knowledge and technology, which overflow their vibe and their dynamics to society. They cannot be exclusive spaces, isolated and separated from the urban and social context. Successful models of technology parks cannot simply be copied. An ideal model of a technology park would be one that considers its local roots (vocations and potentialities), and which is planned to have international projection. Therefore, each technology park project is unique.

The experience of the Springboard Innovation Hub demonstrates that the technology park should be an environment of technological, economic and social development for the city, promoting technological innovation, new business, quality jobs, networking and quality of life, while integrating a place to work, live, learn and have fun. Correctly planned and managed, the park should be able to give national and international visibility to its companies and related institutions. In this way, it should be able to create synergy, projects and businesses between teaching and research institutions, technology centers, companies and other players in the global innovation ecosystem.

Analyzing Centennial Campus as a research park, as explained above, the conceptual and qualitative correlation between the boundary conditions and the success factors of the management of science and technology parks and the four dimensions proposed from the conceptual basis of the Triple Helix, as shown in Table 3. For the points of correlation between management dimensions and success factors, the objectives to be pursued by the technology park were stated in order to guarantee their institutional mission as a driver of development through the promotion of technological innovation, carried out in accordance with the view of the Triple Helix.

The construction of the proposed objectives, presented in Table 3, which should guide the park's management and which can influence its performance, was developed considering that the Centennial Campus, through the Springboard Innovation Hub, seems to have found the right formula to engage and align the needs of industry, government and university, acting as a "driver" for the Triple Helix Model. Thus, uniting the Springboard Innovation Hub environment and services with NC State's academic and research excellence with world-class researchers, Centennial Campus has become a perfect "testing ground" for testing high technology and innovative projects. This experience is reflected in the conceptual management model presented in Table 3, which should be understood as a reference model.

According to the management model presented in Table 3, which can be adopted by the managers for the planning and management of the park, the value proposition of the technology park is in the offer of technological services of high added value to the companies and the stakeholders linked to the park, which, together with access to scientific and technological knowledge, physical infrastructure, financing and networking, will contribute to the economic, scientific and technological development of the region, with innovation as a driving force.

Table 3 Conceptual Model of Technology Parks Management, According to the Relationship Between the Triple Helix and the Success Factors and Boundary Conditions

Science and technology park		Conceptual basis of the Triple Helix			
		Technical and scientific dimension	Business dimension	Dimension of sustainable development	Dimension of internal processes
Boundary condition	Success factor	Intellectual capital R & D & I Projects Entrepreneurial culture	Innovation Networking High value solutions	Social and Environmental. Economic Financial	Entrepreneurial culture Culture of innovation Networking and Leadership
Scientific and technological basis	Universities of relevance Research Institutes Research and development centers Reference Hospitals Qualified research groups	Promoting innovation culture Promoting Entrepreneurial University Culture	Promoting innovation culture Assist companies in developing new products	Establish social impact projects financed with public or private resources	Assist in the process of creating new technology-based companies: *spin-offs e startups*
Government support	Regulation mark Innovation policies Funding policies for parks and businesses Involvement of governments	Investing in the establishment of R & D & I projects	Investing in the establishment of P & D & I projects	Investing in the establishment of P & D & I projects Investments in infrastructure	Promote alignment among stakeholders that impact governance processes
Skilled labor	Skilled labor Availability of training Presence of renowned specialists Technical and scientific skills	Promoting university-business interaction	Prospect and attract anchor companies	Work for the attraction of new companies to the park environment Ensure the quality of employment and income	Provide professional qualification actions
Location	Regional economy thriving Local entrepreneurial culture Attractive place to live Regional Trade Associations	Provide professional qualification actions	Develop networking	Attract and retain professional talents	Promoting quality of life
Infrastructure	Quality physical infrastructure Availability of facilities Communication networks (high performance)	Leverage new business development	Prospecting and attracting new companies and businesses to the park environment	Provide innovation infrastructure for local development	Develop internal and external communication channels
Service Infrastructure	Consulting and advisory services Intellectual Property Services Technology transfer services Communication and Networking Services	Establish a portfolio of services for companies	Establish service portfolio Attracting public and private investments	Raise funds through development projects Support the creation of state-of-the-art technology centers	Establish service portfolio
Company profile	Development of spin-offs and startups Presence of anchor companies Technology-based companies	Establish acceleration and incubation programs Assist in the processes of technology transfer and knowledge	Prospecting and attracting new companies and businesses to the park environment Develop new markets	Developing economic sustainability	Develop *networking*
Park management	Legal Model Management model Governance Qualified management team	Promoting Entrepreneurial University Culture Establish governance processes	Capturing resources in cooperation	Develop financial sustainability	Develop leadership
Image and reputation of the park	Partner Network Confidence Legal security	Assist in the processes of technology transfer and knowledge	Offer events, fairs, workshops, etc.	Promote the participation of the local community in activities developed by the park Capturing resources in cooperation	Establish a communication and marketing plan Promoting Entrepreneurial University Culture

For the implementation of an appropriate management model, the technology park should have a team dedicated to prospecting and attracting innovative technology-based companies that act as technology providers in the priority areas, as well as companies considered to be traditional, but which depend strategically on the intensive use of technology to operate in the prioritized sectors. In this context, the park will be able to build

networks of relationship, collaboration and networking that combine the areas of activity with the regional economic sectors.

The reference model for strategic management of the performance of technology parks, presented in Table 3, represents, in essence, a way for park managers to establish a strategic management system capable of promoting alignment and focus, considering the different interests of the Triple Helix actors, as well as the mission of the park. This means that the park must make the strategy an ongoing process, with the definition of activities and responsibilities for all involved. As a reference model for the strategic management of technology parks, managers must use it to adapt it to the reality of the technology park, defining metrics for the stated objectives that are in line with the park's maturity and capacity of resources, and as aligned as your strategic plan.

It is expected that the technological park managed in this way, could enhance its impact to the region, as well as achieve the desired results with its creation, for the different actors of Triple Helix. One of the main results of the park for society is the generation of quality jobs and income, contributing to social and economic development. The other expected results with the implementation of the objectives proposed in the theoretical conceptual management model are:

- New investments in projects and activities intensive in scientific knowledge, promoting technological innovation.
- Creation and development of new technology-based companies, contributing not only to the generation of high-quality jobs, but also to the retention of human and intellectual capital.
- Increasing the competitiveness of companies by increasing value added by innovation in products, services and processes, as well as by developing new business.
- Increased interaction, synergy and articulation between companies and ICTs, government institutions and business institutions.
- Increased excellence in higher education institutions, science and technology.
- Promoting the environment and culture of innovative entrepreneurship in the region.
- Establishment of new public policies in order to establish legal conditions and an environment favorable to innovation, entrepreneurship, science and technology and the creation of new enterprises and businesses.
- Increased creation of spin-offs and startups.
- Development of more efficient mechanisms of technology transfer between research institutions and companies.

5. Conclusion

The innovation environments known as technology parks, or scientific parks or university parks, represent a worldwide phenomenon as agents of promotion of scientific and technological development and consequently of economic and social development. Regardless of the management model adopted, a technology park must be an organization managed by highly qualified professionals who, through an innovative synergy of policies, programs, infrastructure, resources and services with high added value, stimulates and manages the flow of knowledge and technology between universities and companies, facilitates the creation and attraction of new ventures and businesses, as well as leverages the growth and competitiveness of resident companies and meets the needs and expectations of stakeholders.

A relevant issue in the context of technology parks is the development of more robust planning, management and performance evaluation systems, capable of being deployed by managers and stakeholders, in order to promote greater integration of resources and value. From this point of view, the conceptual basis of study is based on the Triple Helix model that postulates that the interaction between university-industry-government is the key to promoting innovation in the knowledge economy and that science and technology parks are organizational mechanisms that can favor this interaction. The triple helix model differs from the traditional national innovation system because of the relevance of the role of the university and because in addition to the interaction between the actors, it is expected that each sphere, which makes up each axis of the helix, can also assume roles and functions of the another sphere.

Thus, this work has as general objective to present a theoretical conceptual reference model on the management of technology parks that considers the relations of the concepts of the Triple Helix with the main factors of success and boundary conditions that can influence the performance. We used a methodological approach comprised of the theoretical framework and case study. The case study revealed that Centennial Campus offers uniqueness and differentiation between industry, academia and government, which has made it one of the top destinations for innovative collaboration between businesses, companies and education. It is almost a "self-sustaining city", within a university campus (literally), where its main anchor is NC State itself. The Centennial Campus can be considered an exemplary park, as far as its role as an intermediary organization concerns in promoting the Triple Helix.

With the case study and the bibliographical reference it was possible to propose the theoretical conceptual reference model on the management of technology parks that considers the relations of the concepts of the Triple Helix with the main factors of success and boundary conditions that can influence its performance. Thus, the main result of this work is the management model itself, proposed here and validated through the case study. The model can be used as a managerial tool, which will allow the managers and stakeholders of the park to conduct planning and actions for the future of the enterprise, in a systemic and integrated way. The model's perspectives are coherently interconnected and represent dimensions of internal and external performance, considered strategic in the context of technology parks. New case studies need to be done so that the model can be expanded and strengthened.

Acknowledgements

To financial support received for postdoctoral studies at the *Centennial Campus* of *North Caroline State University* (USA), by the Coordination for the Improvement of Higher Education Personnel (CAPES), according to the Program Post-Doctoral Science and Technology Parks (PCTI 2014), Call Notice 69/2014.

To the ORIED team for hosting and supporting the development of the postdoctoral project.

References

Angle Technology (2003). Evaluation of the past & future economic contribution of the UK Science Park Movement.

Anprotec & ABDI (2008). "Parques Tecnológicos no Brasil – Estudo, Análise e Proposições", in: *Apresentado no XVIII Seminário Nacional de Parques Tecnológicos e Incubadoras de Empresas*, Brasília.

ANPROTEC (s.d.). "Associação Nacional de Entidades Promotoras de Empreendimentos Inovadores", accessed on 17 de set. de 2015, available online at: http://www.anprotec.org.br.

Association of University Research Parks (AURP) & Battelle Technology Partnership Practice (2013). "Driving regional innovation and growth: The 2012 survey of North America University Research Parks".

AURP (s.d.). "Association of University Research Parks", accessed on 17 de set. de 2015, available online at: http://www.aurp.net/what-is-a-research-park

Bakouros Y. L., Mardas D. and Varsakelis N. (2002). "Science park, a high tech fantasy?: An analysis of the science parks of Greece", *Technovation*, Vol. 22, pp. 123-128.

Barr S. H., Baker T., Markham S. and Kingon A. (2009). "Bridging the valley of death: lessons learned from 14 years of commercialization of technology education", *Academy of Management Learning & Education*, Vol. 8, No. 3, pp. 370-388.

Bellavista J. and Sanz L. (2009). "Science and technology parks: Habitats of innovation: introduction to special section", *Science and Public Policy*, Vol. 36, No. 7, pp. 499-510.

Bellgardt F., Gohlke J., Haase H., Parzonka R. and Schicketanz J. (2014). "Triple helix and residential development in a science and technology park: the role of intermediaries", *Triple Helix*, Vol. 1, No. 10, pp. 1-14.

Bigliardi B. et al. (2006). "Assessing Science parks' performances: Directions from selected Italian case studies", *Technovation*, Vol. 26, pp. 489-505.

Cantisani A. (2006). "Technological innovation processes revisited", *Technovation*, Vol. 26, pp. 1294-1301.

CENTRO DE APOIO AO DESENVOLVIMENTO TECNOLÓGICO (CDTR) & MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E INOVAÇÃO (MCTI) (2014). Estudo de projetos de alta complexidade indicadores de parques tecnológicos, CDT/UnB, Brasília.

Chaia S. and Shihb W. (2016). "Bridging science and technology through academic-industry partnerships", *Research Policy*, Vol. 45, pp. 148-158.

Chiochetta J. C. (2010). "Proposta de um modelo de governança para Parques Tecnológicos", p. 208, Tese, Doutorado em Engenharia de Produção, Porto Alegre: Programa de Pós-Graduação em Engenharia de Produção, Universidade Federal do Rio Grande do Sul, available online at: http://www.lume.ufrgs.br/bitstream/handle/10183/28794/000770257.pdf?sequence=1.

Cooper D. and Schindler P. (2003). *Métodos de pesquisa em administração*, Porto Alegre: Bookman.

Coughlan P. and Coghlan D. (2002). "Action research action research for operations management", *International Journal of Operations & Production Management*, Vol. 22, No. 2, pp. 220-240.

Dabrowska J. (2011). "Measuring the success of science parks: Performance monitoring and evaluation", *XXVIII IASP World Conference on Science and Technology Parks*, pp. 1-23.

Danneels E. (2002). "The dynamics of product innovation and firm competences", *Strategic Management Journal*, Vol. 23, No. 12, pp. 1095-1121, available online at: http://www.jstor.org/stable/3094297.

Etzkowitz H. (2003). "Innovation in innovation: The Triple Helix of university-industry-government relations", *Social Science Information*, Vol. 42, No. 3, pp. 293-337.

Etzkowitz H. (2003a). "Innovation in innovation: The Triple Helix of university-industry-government relations", *Social Science Information*, Vol. 42, No. 3, pp. 293-337.

Etzkowitz H. (2003b). "Research groups as 'quasi-firms': the invention of the entrepreneurial university", *Research Policy*, Vol. 32, pp. 109-121.

Etzkowitz H. (2009). *Hélice Tríplice: Universidade-indústria-governo: inovação em movimento*, Porto Alegre: Edipucrs.

Etzkowitz H. and Leydesdorff L. (2000). "The dynamics of innovation: from National Systems and 'Mode 2' to a Triple Helix of university–industry–government relations", *Research Policy*, Vol. 29, pp. 109-123.

European Comission (2007). "Regional research intensive clusters and science parks", European Communities, Brussels.

Faria A. F. and Kekas D. (2016). "A research park as an engine for the Triple Helix Model of industry, government and academic interactions: Centennial Campus' Springboard Innovation Hub case study", Em A. Meerman, & T. Kliewe (Eds.), *Good Practice Series 2016 — Fostering University-Industry Relationships, Entrepreneurial Universities Anda Collaborative Innovation*, Amsterdan: University Industry Innovatio Network, pp. 79-90.

Ferguson R. and Olofsson C. (2004). "Science parks and the development of NTBFs — Location, survival and growth", *Journal of Technology Transfer*, Vol. 29, pp. 5-17.

Fukugawa N. (2006). "Science parks in Japan and their value-added", *International Journal of Industrial Organization*, Vol. 24, pp. 381-400.

Fundação Certi (2013). *Compilação das Dinâmicas do Workshop ANPROTEC*, ANPROTEC, Recife.

Gargione L. A., Plonski G. and Lourenção P. (2005). "Fatores Críticos de Sucesso para Modelagem de Parques Tecnológicos Privados no Brasil", in: *XI SEMINÁRIO LATINO-IBEROAMERICANO DE GESTIÓN TECNOLÓGICA* (ALTEC).

Gil A. C. (2006). *Métodos e Técnicas de Pesquisa Social* (5th ed.), São Paulo: Atlas.

Hansson F., Husted K. and Vestergaard J. (2005). "Second generation science parks: From structural holes jockeys to social capital catalysts of the knowledge society", *Technovation*, Vol. 25, pp. 1039-1049.

Hansson F., Husted K. and Vestergaard J. (2005). "Second generation science parks: from structural holes jockeys to social capital catalysts of the knowledge society", *Technovation*, Vol. 25, pp. 1039-1049.

Helmers C. (08 de March de 2011). "What makes science parks successful", *University World News*, Issue 170.

IASP. (s.d.). International Association of Scientific Parks and Areas of Innovation, accessed on 03 de fev. de 2015, available online at: http://www.iasp.ws/the-role-of-stps-and-innovation-areas.

Ivanova I. A. and Leydesdorff L. (2014). "Rotational symmetry and the transformation of innovation systems in a Triple Helix of university–industry–government relations", *Technological Forecasting & Social Change*, Vol. 86, pp. 143-156.

Jia N., Gao J. and Cao S. (March de 2015). "Tsinghua Science Park — Source of Chinese entrepreneurial innovation", *Harvard Business Review*, Study Case.

Johnson W. H. (2008). "Roles, resources and benefits of intermediate organizations supporting triple helix collaborative R&D: The case of Precarn", *Technovation*, Vol. 28, pp. 495-505.

Jongwanich J., Kohpaiboon A. and Yang C. H. (2014). "Science park, triple helix, and regional innovative capacity: Province-level evidence from China", *Journal of the Asia Pacific Economy*, Vol. 19, No. 2, pp. 333-352.

Júnior A. C., Porto G. S., Pacífico O. and Júnior A. P. (2015). "Project stakeholder management: A case study of a Brazilian science park", *Journal of Technology Management & Innovation*, Vol. 10, No. 2, pp. 39-49.

Kharabsheh R. (July de 2012). "Critical success factors of technology parks in Australia", *International Journal of Economics and Finance*, Vol. 4, No. 7.

Kharabsheh R., Magableh I. and Arabiyat T. (November de 2011). "Obstacles of success of technology parks: The case of Jordan", *International Journal of Economics and Finance*, Vol. 3, No. 6.

Leydesdorff L. (2000). "The triple helix: an evolutionary model of innovations", *Research Policy*, Vol. 29, pp. 243-255.

Link A. N. (August de 2014). "Competitive advantages from university research parks", Department of Economics Working Paper Series, 16, available online at: http://bae.uncg.edu/assets/research/econwp/2014/14-06.pdf.

Link A. N. and Scott J. (2003). "U.S. science parks: The diffusion of an innovation and its effects on the academic missions of universities", *International Journal of Industrial Organization*, Vol. 21, pp. 1323-1356.

Link A. N. and Scott J. (2005). "Opening the ivory tower's door: An analysis of the determinants of the formation of U.S. university spin-off companies", *Research Policy*, Vol. 34, pp. 1106-1112.

Link A. N. and Scott J. (2006). "U.S. university research parks", *Journal of Productivity*, Vol. 25, pp. 43-55, doi: 10.1007/s11123-006-7126-x.

Löfsten H. and Lindelöf P. (2002). "Science Parks and the growth of new technology-based firms — Academic-industry links, innovation and markets", *Research Policy*, Vol. 31, pp. 859-876.

Mello C. H., Turrioni J., Xavier A. and Campos D. (jan./fev. de 2012). "Pesquisa-ação na engenharia de produção: proposta de estruturação para sua condução", *Produção*, Vol. 22, No. 1, pp. 1-13, doi: 10.1590/S0103-65132011005000056.

Metcalfe A. S. (2010). "Examining the trilateral networks of the Triple Helix: Intermediating organizations and academy-industry-government relations", *Critical Sociology*, Vol. 36, No. 4, pp. 503-519.

Miguel P. A. (Jan./Abr. de 2007). "Estudo de caso na engenharia de produção: estruturação e recomendações para sua condução", *Produção*, Vol. 17, No. 1, pp. 216-229.

Minguillo D., Tijssen R. and Thelwall M. (2015). "Do science parks promote research and technology? A scientometric analysis of the UK", *Scientometrics*, Vol. 102, pp. 701-725.

Ministério de Ciência, Tecnologia e Inovação (MCTI) (2015). *Propostas de Políticas Públicas para Parques Tecnológicos e Incubadoras de Empresas*, Brasília.

Monck C. and Peters K. (2009). "Science parks as an instrument of regional competitiveness: measuring success and impact", *XXVI IASP World Conference on Science and Technology Parks*, pp. 1-19.

Moore S. B. and Manring S. (2009). "Strategy development in small and medium sized enterprises for sustainability and increased value creation", *Journal of Cleaner Production*, Vol. 17, pp. 276-282.

Nakagawa M. H. (2008). "Empresa inovadora de base tecnológica:um modelo de desenvolvimento para o contexto brasileiro", São Paulo: Tese (Doutorado) - Escola Politécnica da UNiversidade de São Paulo, Departamento de Engenharia de Produção.

National Academy of Sciences (2009). *Understanding Research, Science and Technology Parks: Global Best Practice: Report of a Symposium*, Washington: National Academies Press, available online at: http://www.nap.edu/catalog/12546/understanding-research-science-and-technology-parks-global-best-practice-report.

National Academy of Sciences (2010). "Rising above the gathering storm, revisited: rapidly approaching category 5".

Ndonzuau F. N., Pirnay F. and Surlemont B. (2001). "A stage model of academic spin-off creation", *SME and Entrepreneurship*, Belgium: Research Centre - University of Liége.

O'Shea R. P., Allen T., Chevalier A. and Roche F. (2005). "Entrepreneurial orientation, technology transfer and spinoff performance of U.S. universities", *Research Policy*, Vol. 34, pp. 994-1009.

ORGANIZAÇÃO PARA COOPERAÇÃO ECONÔMICA E DESENVOLVIMENTO (OCDE) (2005). *Manual de Oslo*, Rio de Janeiro: Finep.

Parry M. (Ed.) (2006). *The Planning, Development And Operation of Science Parks* (2nd ed.), Cambridge: UK Science Park Association.

Phan P. H., Siegel D. S. and Wright M. (2005). "Science parks and incubators: Observations, synthesis and future research", *Journal of Business Venturing*, Vol. 20, pp. 165-182.

Pisano G. (2006). "Profiting from innovation and the intellectual property revolution", *Research Policy*, Vol. 35, pp. 1122-1130.

Pisano G. P. and Shih W. (July de 2009). "Restoring American competitiveness", *Harvard Business Review*.

Radas S. and Bozic L. (2009). "The antecedents of SME innovativeness in an emerging transition economy", *Technovation*, Vol. 29, pp. 438-450.

Schmidt S. and Balestrin A. (2015). "Brazilian incubators and science parks' resources and R&D collaboration", *Journal of Technology Management & Innovation*, Vol. 10, No. 3.

Schumpeter J. A. (1961). *Teoria do desenvolvimento econômico*, São Paulo: Fundo de Cultura.

Senge P. M. and Goran Carstedt (WINTER de 2001). "Innovating our way to the next industrial revolution", *MIT Sloan Management Review*.

Siegel D. S., Waldman D. and Link A. (2003). "Assessing the impact of organizational practices on the relative productivity of university technology transfer offices: An exploratory study", *Research Policy*, Vol. 32, pp. 27-48.

Siegel D. S., Westhead P. and Wright M. (2003a). "Science Parks and the performance of new technology-based firms: A review of recent U.K. evidence and an agenda for future Research", *Small Business Economics*, Vol. 20, pp. 177-184.

Siegel D. S., Westhead P. and Wright M. (2003b). "Assessing the impact of university science parks on research productivity: Exploratory firm-level evidence from the United Kingdom", *International Journal of Industrial Organization*, Vol. 21, pp. 1357-1369.

Teece D. J. (1986). "Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy", *Research Policy*, Vol. 15, pp. 285-305.

Teece D. J. (2006). "Reflections on 'Profiting from Innovation'", *Research Policy*, Vol. 35, pp. 1131-1146.

Tsamis A. (2009). "Science and technology parks in the less favoured regions of Europe: An evaluation of their performance and the parameters of success", The London School of Economics and Political Science, London, p. 458.

Vedovello C. (1997). "Science parks and university-industry interaction: Geographical proximity between the agents as a driving force", *Technovation*, Vol. 17, No. 9, pp. 491-502.

Vedovello C. A., Judice V. M. and Maculan A. M. D. (2006). "Revisão crítica às abordagens a parques tecnológicos: alternativas interpretativas às experiências brasileiras recentes", *Revista de Administração e Inovação (RAI)*, Vol. 3, No. 2, pp. 103-118.

Vergara S. C. (2005). *Métodos de pesquisa em administração*, São Paulo: Atlas.

Vilà P. C. and Pagès J. l. (Maio de 2008). "Science and technology parks: Creating new environments favourable to innovation", *Strategies for Innovation*, pp. 141-149.

Wasim M. U. (2014). "Factors for science park planning", *World Technopolis Review*, Vol. 3, pp. 97-108.

Westhead P. (1997). "R&D "inputs" and "outputs" of technology based firms located on and off science parks", *R&D Management*, Vol. 27, No. 1.

Yin R. K. (2005). *Estudo de caso: planejamento e métodos* (3rd ed.), Porto Alegre: Bookman.

Zouain D. M. and Plonsky G. A. (2006). *Parques Tecnológicos: planejamento e gestão*, Brasília: Anprotec/SEBRAE.