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The relationship between favorable conditions for innovation in technology parks, the innovation produced, and companies' performance

A framework for an analysis model

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Abstract

Purpose – Innovation is today considered a competitive differential for improving the performance of companies, and technology parks are seen as environments with favorable conditions for such innovation. The purpose of this study is to develop a framework for analyzing favorable conditions for innovation in technology parks, the innovations produced and organizational performance.

Design/methodology/approach – To this end, the authors conducted bibliographic research and in-depth interviews with managers of companies based at the Tecnopuc Science and Technology Park, and managers of the park itself, to establish practical support for previous theoretical findings.

Findings – As a result, a framework was developed to link the favorable conditions for innovation, and organizational performance.

Research limitations/implications – The analysis model proposed here synthesizes the contributions made by several scholars on the theme, allowing for a more detailed and integrated interpretation of the phenomenon, namely, the ways through which the effective development of innovation takes place in companies residing in technology parks and the contribution of innovation to the specific performance of companies.

Practical implications – The use of the proposed framework can help direct park managers' action towards those relationships or activities that prove to be ineffective in achieving desired goals.

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Originality/value – The use of the proposed model in empirical surveys will allow for better understanding of the phenomenon involving the features of technology parks and their effects on innovation and the performance of companies installed there, considering that such parks allow them to access resources with lower transaction costs.

Keywords Organizational performance, Company innovations, Favorable conditions for innovation, Technology parks

Paper type Research paper

Introduction

In many areas, innovation is a required ingredient for companies that want to be competitive (Darroch and McNaughton, 2002). It enables them to adjust to the rapid and even disruptive changes in the technological, regulatory and social environments where they operate, as well as provide a means for actively conducting and shaping this change (Ganter and Hecker, 2014). Because of the relevance of innovation to the competitive advantage of companies, innovation research has become an important theme of strategic management studies (Volberda *et al.*, 2013). Some studies have explored the resources required for the development of innovations (Menguc and Auh, 2010; Paladino, 2007; Penrose, 2006) and the transaction costs in innovation-conducive environments (Corsaro *et al.*, 2012; Lee *et al.*, 2010).

Most innovation research has focused on understanding how companies can stimulate technological innovation (Crossan and Apaydin, 2010), a topic that deserves further academic studies (Boly *et al.*, 2014; Ganter and Hecker, 2014). In this innovation-focused context, many government, teaching and research and development (R&D) institutions, as well as companies, are engaged in actions to foster the generation of innovation (Figlioli and Porto, 2012). These initiatives include creating environments that allow increased interaction between these institutions at the local level, also known as innovation habitats, a scenario in which technology parks stand out.

Technology parks have risen to prominence both for the wide range of services provided to companies and other local organizations (through specialized services) and for their territorial and extraterritorial reach (Gaino and Pamplona, 2012). Parks around the world have been developed with different features in terms of creation design, infrastructure, development stage, principles, goals, nature, etc. (European Commission, 2007).

Technology parks, under many different names, are today one of the main development vectors in the context of the knowledge society and global policies based on knowledge and innovation. This environment is now considered important to public development policies (Bellavista and Sanz, 2009). Technology parks create an environment for the companies established there to have access to resources and conditions which they would otherwise not (Barney, 1991), at lower transaction costs (Williamson, 1991).

However, the international literature has shown that many experiences with technology parks failed to achieve the expected results (European Commission, 2007; Gaino and Pamplona, 2012). In this sense, some researchers suggest that future studies should address the assessment of research and development networks (where technology parks are located) and develop ways to identify the interactions that may be relevant for innovation in technology park environments (Chen and Huang, 2004; Minguillo and Thelwall, 2012). Some authors recommend new studies to address innovative assessments and practices regarding the operation of technology parks, to help park-based companies develop more efficient and effective forms of work and results (Gkypali *et al.*, 2016; Yan and Chien, 2013).

Based on the foregoing, a lacuna can be observed in terms of mechanisms to evaluate the contribution of technology parks to the innovations developed by park-based companies. To remedy this, the present study is based on the following research question:

RQ. What is the relationship between the favorable conditions for innovation offered by technology parks, the innovations of companies located there and their respective organizational performances?

This paper aims to develop a framework for analyzing favorable conditions for innovation in technology parks. This will make it possible to determine if the presuppositions in the literature are borne out in practice and how these relations between favorable conditions and results occur.

Literature review

Competitive advantage of technology parks

In general, a technology park is an economic activity zone composed of universities, research centers, industry and tertiary units, which carry out activities based on research and technological development. Technology parks are limited in geographical area, but they maintain network connection with large companies and with public and private research infrastructure, both at the national and international level. Their focus goes beyond R&D activities, as production and marketing of goods and services are allowed and encouraged (European Commission, 2007).

The International Association of Science Parks (IASP) defines technology parks as organizations managed by specialized professionals whose main goal is to increase the wealth of the local community, by fostering the culture of innovation and the competitiveness of associated companies and knowledge-based institutions. To achieve this goal, a technology park stimulates and manages the flow of knowledge and technology between universities, research and development institutions, companies and the market; facilitates the creation and development of innovation-based firms through incubation and spin-off processes; and provides other value-added services, along with high-quality physical space and structure (IASP, 2016).

Technology parks facilitate the management of contracts (formal and informal) (Dettwiler *et al.*, 2006). They are also intended to play an important role in innovation, and consequently in industrial development, and resident companies are expected to carry out research and development with the purpose of presenting new products and/or services in current or new markets (Lindelöf and Löfsten, 2002).

Technology parks, comprising a group of organizations that can maintain inter-organizational relations to foster scientific and technological development, require governance to organize their processes to achieve their goals (Giugliani, 2011). Such governance is based on Transaction Cost Economics (TCE) and the Resource-Based View (RBV), as the park provides resources, allocates and reduces costs and facilitates coordination and interrelation of activities between organizations (Gkypali *et al.*, 2016; Kharabsheh, 2012; Lin and Tzeng, 2009; Löfsten and Lindelöf, 2005; Vasquez-Urriago *et al.*, 2016).

Technology parks are characterized as a hybrid TCE structure (Williamson, 1991), and work through a set of networks that allow companies to maintain their expertise in a given area and simultaneously reduce contractual risks arising from market transactions (Powell *et al.*, 1996). These networks promote complex and reciprocal interdependence relationships, in which the interrelationships between participants are usually coordinated by the network

companies themselves, and the mechanisms for such coordination are facilitated by the interaction dynamics between members (Human and Provan, 1997).

Transaction costs can be affected by the use of collective strategies between companies to reduce opportunism among economic agents (Jarillo, 1988). Collective strategies provide benefits to both hierarchy (improved coordination, reduced transaction costs) and hiring (increased flexibility and enhanced expertise in the production) (Verschoore and Balestrin, 2008). Therefore, TCE helps explain the benefits afforded for the development of innovations in park-based companies, as the park provides an environment where cost reduction can be achieved through collaboration among companies and between companies and universities, governments and the society as a whole (Gkypali *et al.*, 2016; Lin and Tzeng, 2009).

A company's competitive strategy involves a purpose (a motivation for acquiring a competitive advantage) and the organization of resources to achieve this purpose, which means that these resources are directly related to a particular strategic purpose (Penrose, 2006). When a company's competitive advantage is based on innovation, innovation should focus on specific resources and skills for such, which may often require reorganization of available resources (Martin-Rios, 2014).

Every company has a portfolio of physical, financial, human and organizational resources on which they can base their competitive advantages (Fleury and Fleury, 2003). These factors are difficult for competitors to copy, as they involve the tacit nature of resources (Pisano and Teece, 2007) and the unique historical conditions for the development of resources and skills (Barney, 1991). In this context, considering the RBV approach, a company's innovation depends on available resources, which in the case of technology parks favors the innovative process of resident companies (Kharabsheh, 2012; Löfsten and Lindelöf, 2005).

Framework for analysis of favorable conditions for innovation in technological parks

The theoretical model, developed from the works in this literature review section, considers that the favorable conditions for innovation in technology parks (support services, physical infrastructure, relationship networks of resident companies with other companies and relationship networks of resident companies with universities) have a positive impact on innovation (product, process, marketing and organizational) (Bellavista and Sanz, 2009; Cantù, 2010; Cooper *et al.*, 2012; Das and Teng, 2000; Durão *et al.*, 2005; European Commission, 2007, 2013; Figlioli and Porto, 2012; Hewitt-Dundas, 2006; Lindelöf and Löfsten, 2001; Link and Scott, 2007; Moudi and Hajihosseini, 2011; Prajogo and Mcdermott, 2014; Radosevic and Myrzakhmet, 2009; Raghavan, 2005; Rothaermel *et al.*, 2007; Sá and Lee, 2012; Soetanto and Jack, 2013; Vedovello *et al.*, 2006; Volberda *et al.*, 2013; Warren *et al.*, 2009; Ylinenpää, 2001). It also considers, in turn, that these innovations have a positive impact on the performance of resident companies (Belderbos *et al.*, 2015; Das and Teng, 2000; Frishammar and Hörte, 2005; George *et al.*, 2002; Gilsing and Nooteboom, 2006; Gulati, 1995; Gunday *et al.*, 2011; Hughes, 2001; Kanter, 1985; Madrid-Guijarro *et al.*, 2009; OECD, 2007; Sun, 2011).

The constructs are presented here, with their variables and the potential relationships between them, based on empirical studies by several authors addressing the subject. Favorable conditions for innovation in technology parks are represented by support services, physical infrastructure, relationship networks with other companies and relationship networks with universities.

Technology parks provide *support services* that facilitate the management of resident organizations, aiming at more innovative and creative processes and products

(Bellavista and Sanz, 2009; Vedovello *et al.*, 2006). Organizations with limited access to specific knowledge have access to the support they need to overcome this barrier in technology parks (Bellavista and Sanz, 2009).

The main function of the specialized teams that manage technology parks is to create and manage an environment that encourages the transfer of knowledge between the various agents involved in a park (Bellavista and Sanz, 2009). Thus, technology parks provide their tenants with services such as administrative support; consulting and/or counseling services (legal, accounting, management and industrial property); networking (access to clients/suppliers); knowledge sharing; and facilitating access to venture capital and other financing sources (Bellavista and Sanz, 2009; Cantù, 2010; European Commission, 2007; Figlioli and Porto, 2012; Radosevic and Myrzakhmet, 2009). They also provide support in searching for external information (such as high-level research institutes, consultants and entrepreneur groups) and distributing new technologies developed by the companies (Lindelöf and Löfsten, 2002).

Therefore, companies can focus on their core business and on research to develop innovations (European Commission, 2007). Technology parks help to minimize the information costs involved in searching for already-developed technologies (Link and Scott, 2007) and provide support for the development of new technologies (Bellavista and Sanz, 2009; Durão *et al.*, 2005; European Commission, 2007), thereby facilitating companies' innovation process by giving access to intangible resources at reduced cost.

Support services enable companies to develop their technical knowledge resources, external communication and professionalism (Damanpour, 1991) and help in their technical qualification, relationship with markets and access to resources, all of which may foster innovation (Volberda *et al.*, 2013).

Many of the companies located at the Daresbury Science and Innovation Campus (the UK), for example, chose the site to benefit from the support services provided to companies, focusing on potential financial subsidies and investors (79.0 per cent of companies) (Soetanto and Jack, 2013). The results achieved at the MaRS Innovation Centre (Canada) show that networking between companies led to new informal relationships that evolved into future formal partnerships (Sá and Lee, 2012).

Technology parks also seek to make available a set of *physical infrastructure* and equipment to provide a place for innovation, such as basic infrastructure, institutional buildings, business buildings, technological infrastructure and green and social areas (Figlioli and Porto, 2012; Raghavan, 2005). In addition to these features, the infrastructure of universities and partner research institutions – which are typically located close to the park area, and with which the park maintains formal relationships – add to the technological infrastructure available to resident companies, creating a favorable environment for innovation (European Commission, 2007; Figlioli and Porto, 2012). This infrastructure enables companies to develop innovative projects by using technology centers, low-cost research laboratories and shared environments provided by the technology park (Moudi and Hajihosseini, 2011). Science parks provide tangible resources (laboratories and research facilities) to aid research (Cantù, 2010; Soetanto and Jack, 2013).

The *relationship network with other companies* refers to the relationship involving formal or informal collaborations, joint ventures or basic information exchanges among companies located in innovation environments (Soetanto and Jack, 2013). As they are located on the same site, companies can share experiences, business contacts or establish collaborative projects (Das and Teng, 2000).

Companies can use these networks to access intangible resources such as knowledge (Soetanto and Jack, 2013), and repeated interactions are required to gather knowledge that

can enhance the capabilities of a company (Lin *et al.*, 2006). Knowledge gained from a network with other companies is usually information, experience and guidance for solving business problems or challenges and is one of the main attractions for companies to join such a park (Dettwiler *et al.*, 2006; Löfsten and Lindelöf, 2005).

Technology parks are usually associated with strong network effects and high levels of social capital (Cooper *et al.*, 2012; European Commission, 2007). Thus, technology parks bring companies together (Lindelöf and Löfsten, 2002; Link and Scott, 2007), creating more partnership opportunities (Radosevic and Myrzakhmet, 2009).

The most important barrier to introducing innovation for small companies is the lack of external partners (Hewitt-Dundas, 2006), which can be successfully overcome if the company is located in a technology park. For startups, business processes shared by park-based companies can increase their ability to adapt to the market at each stage of their development, especially if they can share the experiences of high-performing companies (Cooper *et al.*, 2012). This was reported as one of the main reasons for companies to be located at the Daresbury Science and Innovation Campus (46.8 per cent of occurrence in the cases analyzed) (Soetanto and Jack, 2013) and at the University of Southampton incubator (Warren *et al.*, 2009).

Technology parks, in general, are closely *related to universities* and research centers. Thus, many innovation-focused companies are attracted by the access to university resources, such as cutting-edge technical knowledge and different types of training (Cooper *et al.*, 2012; Figlioli and Porto, 2012; Rothaermel *et al.*, 2007; Soetanto and Jack, 2013). Parks provide universities with a channel for distributing the technologies they develop, and the proximity to industry reduces development risks (in the case of spinoffs) and provides an information channel in which problems faced by the industry can become interesting lines of scientific research (Bellavista and Sanz, 2009; Link and Scott, 2007).

Parks also provide contact networks with departments of other research institutions, enabling the exchange of knowledge, contracts, agreements, strategic alliances or attraction of talent that go beyond companies' internal possibilities (Bellavista and Sanz, 2009). These collaborations allow companies to develop specialized products or services without the high investments required for internal development (Löfsten and Lindelöf, 2005; Soetanto and Jack, 2013; Warren *et al.*, 2009).

By working with highly innovative products or services, park-based companies are more likely to receive support from former university colleagues or professors to develop ideas, technologies and innovations, which contributes to marketing them (Soetanto and Jack, 2013). Networking with universities was regarded as one of the main motivations for companies to be located at the Daresbury Science and Innovation Campus (56.5 per cent occurrence) (Soetanto and Jack, 2013).

With respect to *innovation*, the prevailing arguments suggest that innovation has the potential to generate returns for firms (Sun, 2011), particularly in terms of product, process, marketing and organizational innovations (OECD, 2007). Frequent collaborations can be attractive for effective learning because they allow the building of trust (Gulati, 1995), supporting the exchange of tacit information and knowledge (Gilsing and Nooteboom, 2006), thus contributing to the innovation process.

An innovation may not produce immediate effects on the *performance* of a company, as it requires a certain period of incubation before performance is increased: however, this consideration will differ depending on the type of the partner. Projects focusing on basic and applied research are likely to need longer periods of time to generate returns (such as product and organizational innovations), but projects to solve every day technological problems can bear immediate results (Belderbos *et al.*, 2015).

Some researchers highlight the positive relationship between innovation and business performance, as in the case of companies located in industrial parks in Turkey (Gunday *et al.*, 2011), while others address the lack of such a relationship, as in the case of companies located in the Hsin Chu Industrial Science Park in Taiwan (Sun, 2011). In general, these different studies suggest a positive relationship between innovation and performance for park-based companies (Gkypali *et al.*, 2016; Vásquez-Urriago *et al.*, 2016). Thus, innovations are expected to have a positive impact on the performance of companies located in technology parks.

The framework of favorable conditions for innovation in technology parks is presented in Table I.

Research method

To verify the proposed framework, this study used an exploratory qualitative approach, as there are few existing studies in this field of knowledge (Gkypali *et al.*, 2016; Tsai and Chang, 2016). The exploratory search was selected because it allows for an inquiry that preserves the holistic and relevant features of the organizational and administrative processes for a set of events that are not controlled by the researcher, developed in a delimited territory, Tecnopuc (Yin, 2009). Tecnopuc is the Scientific and Technology Park of the Pontifical Catholic University of Rio Grande do Sul (PUCRS) in Brazil, which harbors 120 organizations and a total of 6,300 employees and which has been recognized as the best technology park in Brazil by ANPROTEC (Brazilian Association of Science Parks and Business Incubators) (Tecnopuc, 2016).

The exploratory qualitative character also comes across as appropriate when one takes into account, as previously mentioned, the diversity of typologies and characteristics of

Table I. Framework of favorable conditions for innovation in technology

Dimension	Constructs	Authors
Favorable conditions for innovation in technology parks	Support services	Bellavista and Sanz (2009, Cantù (2010), Figlioli and Porto (2012), Lindelöf and Löfsten (2002), Link and Scott (2007), Moudi and Hajihosseini (2011), Radosevic and Myrzakhmet (2009), Vedovello *et al.* (2006)
	Physical infrastructure	Bellavista and Sanz (2009), Colombo *et al.* (2006), European Commission (2007), Figlioli and Porto (2012), Lindelöf and Löfsten (2002a), Moudi and Hajihosseini (2011), Soetanto and Jack (2013), Warren *et al.* (2009), Ylinenpää (2001)
	Relationship network with other companies	Bellavista and Sanz (2009), Cantù (2010), Damanpour (1991), Dettwiler *et al.* (2006), European Commission (2007), Löfsten and Lindelöf (2005), Soetanto and Jack (2013), Volberda *et al.* (2013)
	Relationship network with universities	Bellavista and Sanz (2009), Cooper *et al.* (2012), European Commission (2007), Figlioli and Porto (2012), Löfsten and Lindelöf (2005), Rothaermel *et al.* (2007), Soetanto and Jack (2013), Warren *et al.* (2009)
Innovation	Product Process Marketing Organizational	Gilsing and Nooteboom (2006), Gulati (1995), Gunday *et al.* (2011), OECD (2007), Sun (2011)
Performance	Organization Performance	Belderbos *et al.* (2015), Gkypali *et al.* (2016), Gunday *et al.* (2011), Sun (2011), Vásquez-Urriago *et al.* (2016)

Source: Prepared by the authors

technology parks, which could lead to an excessive modeling complexity. Thus, consulting "practitioners", experts who work in a scientific and technology park such as Tecnopuc, allows a better practical understanding of the phenomenon (Yin, 2009).

The bibliographic research helped to build the theoretical framework and define the possible categories of analysis, thereby contributing to the script of the semi-structured survey applied to eight PUCRS innovation ecosystem managers (PM) and five company managers (CM) based in Tecnopuc. The surveys were carried out between May 2015 and January 2016 and each took an average of 55 minutes. All interviewed PMs have at least three years of experience in ecosystem management and are the leaders in their activities (Provost, Directors and Coordinators working in the innovation area of the University). All the interviewed CMs had been based at Tecnopuc for at least two years: one was with a large company, two with medium-sized companies and two with small companies.

The study used in-depth interviews. The semi-structured script was based on the bibliographic review, with a broad field of questions to address new propositions that arise as responses that are given by the interviewee. This script was verified by two researchers in the area of innovation, to confirm that it was adequate to meet the goal of this study. For content analysis (Bardin, 1977), it was decided to use the open grid categories of analysis after the interviews were transcribed, in which the categories arise during the research and undergo changes until arrival at the final categories of analysis, with the support of NVivo software (Vergara, 2005).

The interview findings helped complement the bibliographic review, because the interviews reported on practical cases of how conditions that favor innovation interact with innovation itself in TECNOPUC companies and how they influenced performance. Testing the findings of the literature against the interviews with park and company managers enriched the study.

Results obtained

Tecnopuc, the PUCRS Scientific and Technology Park, was created in 2001. The old facilities of the regional army command, an area adjacent to the university, were purchased and remodeled by PUCRS to meet the research and development needs of the modern operations performed by the university's partner-companies (Tecnopuc, 2016).

Tecnopuc's original vocation was the Information and Communications Technology (ICT) industry, especially given the promulgation in 1991 of Brazil's "Lei da Informática" (legislation covering the IT sector of the economy), but it now encompasses the following sectors: electronics, energy and environment, biological and health sciences, biotechnology and creative industries. What follows is a discussion of the results of the data collected from the interviewees at Tecnopuc and its member companies.

Favorable conditions for innovation in technology parks

Park managers (PM) reported that many companies seek out Tecnopuc based on the park's image, in the hope that it will give them access to scientific knowledge, proper infrastructure and qualified staff. Company managers (CM) stated that many companies are located in parks to access state-of-the-art knowledge, as there is the possibility of forging relationships with researchers renowned in their fields, who can contribute to the development of companies. Companies located in the park also have access to qualified labor and experience exchange among companies.

PMs said in their experience, the smaller the company, the greater will be the park's influence on its development, as smaller companies make more frequent use of the park's

innovation ecosystem. CMs, on the other hand, stated that many small-sized companies lack the financial resources to establish a relationship with the university.

In relation to *support services*, PM interviewees referred to the importance of having the right people to lead this innovation ecosystem: support services facilitate innovation, opening pathways so that entrepreneurs can move ahead with innovation. They further added that smaller companies use these services more frequently. CM interviewees reported that the park offers important services that open doors for the development of innovative processes in companies, which would be difficult to obtain if they were not in this environment. The authors analyzed in the review (Bellavista and Sanz, 2009; Radosevic and Myrzakhmet, 2009) agree with these responses: however, the variation in the frequency with which these services are used, according to company size, was a new element introduced by the interviewees.

Physical infrastructure, on its turn, helped create relationships among entrepreneurs, allowing for a technology environment, according to PMs. However, some PMs commented that "selfish behavior" still persists among some CMs, who are reticent to share resources with other entrepreneurs. One of the interviewees (PM) reported that the technological infrastructure offered by the park must be the most influential factor for innovation, and the park has examples of companies sharing infrastructure with other companies so they can develop projects together; however, for the most part, companies use the facilities offered by the university. The PMs interviewed reported that physical infrastructure facilitates the innovation process of companies once they have access to state-of-the-art infrastructure that they would not otherwise have. Nevertheless, three of the interviewees (CMs) stated that the use of such infrastructure is not optimized yet, because companies still lack the culture of using it because of lack of resources (especially technical resources, connected to the limited structure of smaller companies). This aspect of the interviews revealed a point that was not addressed by the analyzed literature (Figlioli and Porto, 2012; Raghavan, 2005), which is that companies fear exposing their strategies and *modus operandi* to other companies in the park.

PM interviewees stated that the *relationship networks among companies* do not "run smoothly" yet, but are important to boost innovation in parks. One of the interviewees (PM) said that there are very productive relationships between some companies in the park, which allowed them to pursue new business opportunities. As suggested in the literature (Moudi and Hajihosseini, 2011), these synergies are great alternatives that allow companies to develop new solutions, and there are cases in the park of companies that have managed to develop new businesses in this way. Some interviewees remarked that many companies ended up generating their relationship networks in an involuntary fashion, given that their use is highly dependent on the will of the company to relate to others within the park. CMs reported that the park environment is very conducive to developing a relationship with other companies, that park management seeks to foster such relationships and that important relationships exist for some companies in this environment, who are either clients or suppliers of neighboring companies. The accounts of both groups of interviewees (PM and CM) about this aspect were very similar to what is addressed by the literature (European Commission, 2007; Moudi and Hajihosseini, 2011; Radosevic and Myrzakhmet, 2009; Soetanto and Jack, 2013).

The *relationship networks among companies and universities* often take place based on projects developed together, according to PMs. They pointed out that several companies have a strong relationship with the university, but that a higher number of interactions could be built up. One of the PMs reported that it is still necessary to change some of the companies' behaviors, so they can develop more innovations by having a more collaborative

perspective. CMs said that there is a very important misalignment of the time frames for companies and the university: because often need solutions in the short term, while university deadlines tend to be longer. Another point raised by CMs is that some companies have trouble relating to the university, as they have a lean structure and lack the resources to invest in this relationship (Damanpour, 1991). The interviews showed evidence supporting authors who were analyzed in the bibliographic review (Lindelof and Lofsten, 2002; Moudi and Hajihosseini, 2011; Vedovello *et al.*, 2006).

Innovation

Regarding the companies in the park, all PMs interviewed stated that the companies developed some type of innovation; however, most of the interviewees said these companies could do more, as there is still a lack of an innovation management culture. The same interviewees reported that the majority of verified innovations are incremental product or process (technological) innovations, given that smaller companies tend to develop product innovation. CMs said that the companies developed innovations and also reported that almost all innovations are incremental, which supports the literature on the theme.

Product innovation was mentioned by all interviewees as being present in the park, as all companies that reside in the park have a technological basis. PMs mentioned that usually the more innovative a company is, the better its market performance tends to be. They added that many companies have outstanding technological products in the market and that emerging companies usually develop to commercialize a product innovation, corroborating what authors in the area report (Moudi and Hajihosseini, 2011). CMs stated that their companies create product innovations and that the park is a fertile field for innovation once companies realize that neighbor companies are also innovative, especially when it comes to product innovation. Thus, interviewees realize that the technology park, in general, contributes to fostering innovation among park-based companies (Gaino and Pamplona, 2012; Link and Scott, 2007; Vásquez-Urriago *et al.*, 2016).

Regarding *process innovation*, PMs said that this facet is influenced by the conditions offered by the park, as the proximity to other organizations (companies, universities, etc.) allows them to exchange experiences and that larger companies tend to have more process innovations than smaller companies. CMs stated that this is the most frequent type of innovation in companies, which to keep renovating themselves to remain competitive, which matches the reviewed literature (Basile, 2011; Damanpour and Aravind, 2011; Tzeng, 2010).

Marketing innovation is typically influenced by actions promoted by the park for companies to exchange experiences, according to the PMs, who also report that these events are usually attended by smaller companies. The same interviewees stress the fact that the park is working to develop new markets for information technology companies through *softlanding* (support for internationalization) with other countries. CMs stated that being in a technology park provides companies with visibility, thus facilitating the development of marketing innovation, as the park offers an enabling environment for the development of this type of innovation. Such actions carried out by the park are one of the goals of these establishments, according to the reviewed literature (Kharabsheh, 2012; Radosevic and Myrzakhmet, 2009).

Organizational innovation is more frequently seen in small companies, according to PMs, because they very often need to reorganize internally because of the development of new businesses, and need to adjust their structure to meet new demands. CMs stated that this type of innovation is typically developed when companies get involved with new challenging projects and is less frequent in bigger companies. This type of organizational

innovation is very common in startups, according to the bibliographic references (Chang *et al.*, 2006).

Based on the interviews one can establish that both PMs and park-based companies (CM) realize that the various conditions offered by the park contribute, in diverse degrees and forms, to the development of innovations by the companies, as one would expect from the bibliographic review (Cantù, 2010; Figlioli and Porto, 2012; Kharabsheh, 2012; Moudi and Hajihosseini, 2011; Radosevic and Myrzakhmet, 2009).

Organizational performance of companies residing in technology parks

Companies residing in parks tend to be more innovative, according to the perception of PMs, potentially generating more *organizational performance*, which can be seen, in principle, by the innovations they develop. PMs stated that new production methods have been developed by the companies residing in the park, generating better production performance. This situation is also approached in the bibliographic review (Albahari *et al.*, 2017; Gkypali *et al.*, 2016), which focuses on the innovation results or performance of companies that are installed in the park. According to PMs, and supported by CMs, participation in events promoted by the park provides companies with access to new forms of commercialization and new clients and/or suppliers, thus allowing them to achieve better performance from a market perspective. According to PMs and CMs, these performance increments arising from innovation are frequently not perceived through the short-term financial perspective of these companies (Chan *et al.*, 2009; Gkypali *et al.*, 2016).

Final considerations

Based on the theoretical review and the exploratory field interviews about the conditions that favor innovation in technology parks, the innovations either introduced or developed by the park-based companies and their respective performances, it was possible to design a framework, and it was verified.

The field research, through in-depth interviews with Tecnopuc managers (PM) and the managers of park-based companies (CM), generally reinforced and complemented the findings of the empirical studies in the bibliographic review, which supports the propositions of the model that was designed and presented above.

One can realize, through the managers' reports, that companies residing in parks benefit from the favorable innovation environment and make use of the facilities offered by the park to facilitate the innovation process. Based on the data collected from the interviewees, it was also verified that most of the companies incorporate innovation in their routines. However, according to the perception of the park managers interviewed, these interactions between companies and university could be better used by all the managers involved.

As academic contribution, the analysis model proposed here synthesizes the contributions made by several scholars on the theme (Cantù, 2010; Gkypali *et al.*, 2016; Lindelöf and Löfsten, 2002; Moudi and Hajihosseini, 2011; Radosevic and Myrzakhmet, 2009; Vásquez-Urriago *et al.*, 2016), allowing for a more detailed and integrated interpretation of the phenomenon, namely, the ways through which the effective development of innovation takes place in companies residing in technology parks and the contribution of innovation to the specific performance of companies.

The use of the proposed model in empirical surveys will allow for better understanding of the phenomenon involving the features of technology parks and their effects on innovation and the performance of companies installed there, considering that such parks allow them to access resources (Barney, 1991) with lower transaction costs (Williamson, 1979). This type of inter-business arrangement has been settled through the past few years

as the major technology development in the local, regional and even national environments (Bellavista and Sanz, 2009; Moudi and Hajihosseini, 2011). However, there is the need to verify whether, for instance, the park contributions are the same for all types of innovation or not. It must also be verified if innovation actually reflects on companies' performance and in which of its dimensions (Gunday *et al.*, 2011).

In terms of management contribution, the use of the proposed framework can help direct park managers' action towards those relationships or activities that prove to be ineffective in achieving desired goals. For instance, the practical experimentation of the model can allow them to realize that some of the proposed relationships are not confirmed in real terms, which should cause them to re-evaluate why the concrete context diverges from the relevant theory.

Among the limitations of this research, it should be stressed that the field research used as a way to support the findings of the conceptual and theoretical reviews is of a qualitative nature, involving the subjectivity of the researchers' interpretation of the analysis and description of the results. Thus, aiming at a potential generalization of the results obtained here, one would need to perform a quantitative study, which is the main reason behind the development of the analysis model proposed here.

Therefore, the results from this exploratory study will serve as a starting point for future research, and it is possible to apply a quantitative approach to check how these relationships take place in the context of technology parks. It is also important to highlight that this article does not completely exhaust the theme, and further studies are necessary to complement it; such studies shall be more clearly identified from the use of the proposed analysis model.

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