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Proposal of a theoretical model for the implementation and scalability of science parks: a case study

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Abstract

The general aim was to propose a theoretical model for the implementation and scalability of science parks. For this purpose, an in-depth study was conducted at the Santos Science Park (SSP), as this is the only implementation and scalability program for science parks in the country whose central focus is on energy (oil and natural gas). The study was qualitative and exploratory in nature and the methodology used was the case study, with data collected from multiple sources. These sources included bibliographic research, document analysis, a workshop and meetings with members of the Board of Directors of the SSP. Information on other consolidated science parks in the country (Tecnopuc in Porto Alegre and Porto Digital in Recife), which was important to the structuring of the theoretical model for the implementation and scalability of the SSP, was obtained from semi-structured interviews with their managers. The results showed that the implementation of the SSP will require not only a legal format and an adequate real estate project, but will also involve the articulation of political, economic and social activities that precede the implementation of the venture. These activities will define the criteria for the concession and use of the park's infrastructure and services. They also include the mechanisms for economic and financial support and social rules that will affect the interface of the park with its resident and non-resident companies and society. The conclusions of the study led to the proposal of a theoretical model for the implementation and scalability of a science park through the development of dynamic, ambidextrous and relational capabilities that together result in a scalable innovation cycle.

Keywords: Implementation; Scalability; Theoretical model; Science park

Introduction

Science parks emerged in the United States in the 1950s and became more commonplace in the 1970s, when they rapidly spread around the world and adapted to the different conditions of each region and country. In Brazil, they have mostly been implemented since the 1990s (Vedovello, Judice, & Maculan, 2006). According to Zouain (2003), Brazil could be considered a latecomer to the field.

Science parks are important because they offer space and services to support the establishment and maintenance of technology-based companies, i.e., companies whose goods or services are characterized by adding value through the knowledge incorporated into their products or processes. The presence of academic research centers, an innovative management style, highly qualified professionals and an excellent communications infrastructure and high quality environment are the common characteristics of science parks (Instituto de Pesquisas Tecnológicas do Estado de São Paulo, 2007; Instituto Prointer, 2002).

The purpose of science parks is to increase the wealth and improve the well-being of the region where they are located by promoting a culture of innovation and competitiveness in

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the technological and scientific institutions associated with them. As these ventures are related to incentives for the production and development of new technological products and processes, these parks are normally managed by highly specialized professionals with close ties to the business and academic communities (Associação Nacional de Entidades Promotoras de Empreendimentos Inovadores, 2008). Because of their importance to the promotion of Science, Technology and Innovation (ST&I), these organizations are emerging as an element of technology policies all over the world (Centro de Apoio ao Desenvolvimento Tecnológico, 2013; International Association Science Park, 2002; Lai & Shyu, 2005).

In specific terms, the United Nations Industrial Development Organization (2005) highlights a basic difference between a traditional science park (implemented up to the late 1990s) and a third generation science park (established after the late 1990s). While the former has high-level strategic management and an operational management policy (management of daily activities), the latter is directly involved in local issues, processes, relationships and results. Furthermore, it manages this entire set of activities efficiently.

In the particular case of Brazil, data from the Ministry of Science, Technology and Innovation (Ministro da Ciência, Tecnologia e Inovação, 2013) reveal that in 2000 the country had around ten science park projects. By 2008, this number had risen to seventy-four. In 2013, 94 parks were being implemented. Thirty-eight of these were at the project stage and twenty-eight at the operational stage. In 2013, there was a greater concentration of parks in the Southeast region (41.5%) and the South (37.2%). In other words, practically four out of five initiatives for science parks were located in these regions. The study by the Ministry of Science and Technology (2013) also showed that in 2013 the science parks in Brazil created 32,237 jobs and housed 939 companies. Many of these were operating in the field of Information Technology (36), the Energy Sector (27) and the Biotechnology Sector (26), and were concentrated in the South (40%), Northeast (32%) and Southeast (25%).

It should be highlighted that a science park offers space to interested entrepreneurs with clear rules for participation, attractive costs and opportunities for partnerships and knowledge sharing. Not only does this require a systematized implementation model for new parks, but also scalability, understood as organizational efficiency linked to the continuous creation of value (Fiates, Chierighini, & Ueno, 2007; Jabbour & Fonseca, 2005; Osterwalder & Pigneur, 2011).

Santos (1997) highlights that the implementation model for a science park should also involve patterns of articulation and cooperation among social and political actors and institutional arrangements that coordinate and regulate transactions from the frontiers of the economic system. This includes not only traditional mechanisms of aggregation and articulation of interests, such as political parties and pressure groups, but also informal social networks (of suppliers and distributors), hierarchies and various types of associations.

Thus, the systematized implementation of a science park also opens up a discussion on the management of resources and organizational processes as a way of achieving the future scalability of the venture. To this end, the principles of dynamic capabilities, ambidextrous capabilities and relational capabilities may be highlighted. These involve, respectively: (a) the processes of creation, extension or modification of the resource base (Helfat et al., 2007); (b) the functions of identifying opportunities (that enable adaptability) and rationalization of resources and processes (that determine alignment), seeking to create more value (Birkinshaw & Gibson, 2004); and (c) inclusion in technological cooperation networks for the creation and collaborative appropriation of value by using funds for cooperation and strategic alliances (Hutabarat & Pandin, 2014; Zott, Amit, & Massa, 2010).

In this situation, the current problem for new third generation science parks, such as the Santos Science Park (SSP), does not involve only systematizing an implementation model. It also requires a study of the possibilities for creating value for resident companies, involvement in local issues and a drive for efficiency in processes, relationships and operational and strategic results. This leads to a reflection on dynamic, ambidextrous and relational capabilities to aid the scalability of the venture. In this context, the following research question emerges: How can the implementation and scalability model of a science park be aligned through the development of dynamic, ambidextrous and relational capabilities?

Specifically regarding São Paulo State, the São Paulo Science Park System (SPPT), officially established in 2006, has a number of projects for the implementation of parks, one of the major ones being the Santos Park. Thus, the intention is to propose a theoretical model for the implementation and scalability of science parks. For this purpose, an in-depth study of the SSP was conducted, as it is the only implementation and scalability program for a science park in the country focusing on the field of energy (oil and natural gas).

It should be stressed that recent academic discussions have revealed challenges regarding the organizational arrangements established by actors interested in innovation and technology. These include agility (Doz & Kosonen, 2008), response capability (Kanter, 2009), balancing innovation and efficiency (Brown & Eisenhardt, 1997; Tushman & O'Reilly, 1997), environmental sensitivity (Henderson & Newell, 2011) and, specifically, a sharp increase in collaborations (Reuer, 2004). This signals a tendency for involvement among actors with unique knowledge, shifting the locus of work that was previously defined as the nucleus of the company or research institute and applying it beyond its frontiers (Baldwin & Von Hippel, 2011).

Therefore, there is a latent theoretical gap in the development of scientific discussions and the proposal of theoretical models regarding the importance of coordination and scalability beyond the frontiers of the company or institute (Gulati & Singh, 1998; Reuer, 2004), given that the theories of organizational structure tend to emphasize the intrafirm and formal authority dimensions (Gulati, Puranam, & Tushman, 2012). In other words, these dimensions are discreet or totally absent in contexts of close collaboration between companies and STIs, which are often formally independent, as in the case of science parks.

Consequently, the study is relevant due to its proposal of a theoretical model for implementation and scalability for a science park through the development of dynamic, ambidextrous and relational capabilities. The combined results could be considered important by agencies that manage implementation projects of new science parks, who, in addition to the implementation of the venture, seek to establish a scalable innovation cycle, with organizational efficiency and creation of value for resident enterprises and the local economy.

Regarding the structure of the article, section "Concept, implementation and scalability of science parks" reflects on the concept and management of science parks. Section "Methodological procedures" looks at the methodological procedures, including details of the method, data collection instruments and analysis categories of the study. Section "Results: legal status, communication and property issues of the SSP" contains an analysis of the results, including the proposal for an implementation and scalability model for the Santos Science Park and a discussion of the variables included in this model. The final section summarizes the main results and outlines the limitations of the study and possibilities for future research.

Concept, implementation and scalability of science parks

Spolidoro and Audy (2008) summarize the concepts of the science park of the National Association of Agencies for the Promotion of Advanced Technologies (Anprotec) and the International Association of Science Parks (IASP), both of which are important to outlining the conceptual framework of the present study.

(a) Concept adopted by the Anprotec: a scientifically and technologically based industrial complex with formal, concentrated and cooperative planning that includes companies whose production is based on technological research conducted at R&D centers linked to the park. Therefore, it is a venture that promotes a culture of innovation, competitiveness and greater business training based on the transfer of knowledge and technology to increase production and wealth.
(b) Concept adopted by the IASP: an organization managed by specialist professionals, where the main goal is to increase the wealth of the surrounding community by promoting a culture of innovation and competitiveness in knowledge-intensive companies and institutions associated with the organization. It stimulates and manages the flow of knowledge and technology between universities, R&D institutes, companies and markets. It promotes the creation and growth of companies based on innovation through incubation mechanisms and spin-offs, and provides space and high quality installations and other added-value services.

Gonçalves (2005) highlights the inaccuracy of the concepts related to science parks and their systematic implementation, apparently due to the widespread use of the term without due analytical care. Thus, systematized implementation could be viewed as practices and relationships between actors to optimize the future performance of a science park and facilitate access to capital by the companies installed there. Therefore, a number of issues are involved that seek to guarantee the participation of multiple actors from the public authorities and civilian society in an understanding of an integrated vision for the future functioning of the park, considering its capacity for performance and information. The actors in this case include the foundations that support the parks, public and private universities, anchor companies, future start-ups and government agencies, representatives from industry, independent auditors and the supervisory board. In short, it has to do with the interaction of the agencies, entities and other parties involved in articulating a science park (Gonçalves, 2005).

According to Spolidoro and Audy (2008), the systematized implementation of a park includes operational management and strategic management. In science parks, the operational management handles the internal administration, which includes the administration of real estate, administrative admission processes and the organization of services provided to resident companies. The strategic management addresses the park's philosophies, aims and goals.

In general, some parks have managerial agencies with specific legal configurations adapted to each situation or reality, in addition to a management committee integrating the articulation structure. In other words, the implementation models of existing science parks have specific characteristics that are inherent to the variations in the forms of operation of each venture. This is due to their geographical location, fields of operations, which are usually related to the characteristics of the industries of development vectors of the region, institutional connections and links to local and regional policies (Spolidoro & Audy, 2008).

According to the United Nations Industrial Development Organization (2005), the management model for the implementation of a third generation science park (which has become the global benchmark) involves public and private participation and has certain characteristics. It presents itself as a global player that will aid the city or region where it is located. It becomes part of the environment, encouraging the development of skills, new technologies and an environmentally conscious working environment. It promotes quality businesses and opportunities for investment through the management of a highly qualified team. It is an essential element of the university, influencing its activities, post-graduate courses and research agenda, and is focused on the needs of the companies that it houses.

Spolidoro and Audy (2008) also highlight certain key managerial elements for the implementation of a science park, such as legal aspects, including norms and regulations that reflect the law (responsibility, transparency and regulatory quality). Other elements are learning from the "critical success factors" and the "best practices" adopted in domestic and international science parks to define the "rules of the game" so that the initiative will be successful and gain visibility. Furthermore, a democratic space should be created for further discussions and decision-making among the various actors, including the authorities, companies from various industrial sectors and service sectors, universities and research institutions. This is to ensure that from the outset

the environment is conducive to the development and diffusion of new technologies. Another important element is having the necessary infrastructure to provide the services offered by the park.

In specific terms, Allen (2007) highlights that a managerial model for the implementation of a third generation science park is a set of management mechanisms intended to achieve the mission of the park. There should also be a management unit capable of establishing articulations between the internal and external actors to serve their interests. For this set of mechanisms to function, it is necessary to have highly trained management professionals working at the management unit. This unit, in a science park, could be a university council, a local government entity (development agency) or a private entrepreneur. In addition to obtaining resources for investment in research, development and innovation and the referral of issues concerning the park's land, the management unit's sphere of influence also includes the management of all the core assets that are important to making the mission a reality.

Kirk and Catts (2004) highlight that in the implementation of a park the founding actors are responsible for establishing a solid management structure through which they can control the development of the venture. They also need to ensure that: (a) the mission of the park always remains the fundamental goal and, consequently, they can counteract direct management by another agency, such as a university council, local government authority or private development agency; (b) the park has the ability to guarantee sufficient funding, land and other essential assets to make the mission a reality; (c) the actors are firmly in tune with one another and aware that the park is a publically owned entity and that there should be a perspective of self-sustainability and adequate accounting with efficient accountability mechanisms; (d) the initial expenses of the park should be limited or planned to allow time for the venture to develop its actions adequately and be aligned with the operational plan, always from a perspective of achieving its mission; and (f) there is a strategic business plan for the development of the park that should be drafted to include a schedule for balancing the level of engagement of the public and private sectors in the project.

Kirk and Catts (2004) also emphasize that the critical or fundamental interests of the actors involved in the park need to be reflected in the composition of the board of directors. When public investment constitutes a considerable part of the initial endowment of a park, the managerial requirements will probably be better met by a non-profit association rather than a shareholder-based company. If the private sector is the leading developer of the park, one of the best legal formats is a company limited by guarantee. The object of the business of the company in question, in this case, will be the development and management of the park's activities.

Regarding the main responsibilities of the management of a science park, Kirk and Catts (2004) highlight the preparation and presentation of the accounting to the founding actors of the park and constantly keeping the vision of the park in perspective and realigning it with the mission whenever circumstances change. They also emphasize developing and publicizing the policies that govern the evolution of the venture and managerial activities and acting as the guardian of the public resources and other interests involved in the park. The organizational performance of the park is generally the responsibility of the management board in the eyes of the Board of Directors. In these cases, the management board should have the executive authority for the operation of the park.

It should also be emphasized that the park is the property of a single research institution (as is the case of traditional science parks). It is most likely that this institution would control the votes of the Board of Directors. When the main actors involved are research institutions, it is recommended that instead of adopting a position of owners/operators of the park, they should be well represented in the management board. In certain situations, it may be difficult to achieve a balance in the relationship between a research institution and a science park. When these institutions own the park or are in a position to control it, they tend to adopt three different roles, sometimes simultaneously. These are creating new knowledge that can rapidly enter the public domain, being educators of the workforce of scientists, engineers, technicians, managers, etc., and acting as entrepreneurs, supporting spin-offs created from research in partnership with resident companies in the park (Kirk & Catts, 2004).

A crucial issue for implementation, therefore, is how the management board (or consortium) chooses to operate the park. In this context, a question for reflection is: Would it be better for the management board itself to operate it or should they hire a complete or partial operation service?

Kirk and Catts (2004) emphasize if that the essential management functions are outsourced, there is a risk of misalignment of these activities in relation to the vision outlined in the implementation stage. On the other hand, direct control requires the management board to hire and develop sufficient internal capabilities to operate the park effectively and competitively. Furthermore, these tasks are not easy, as they involve operations that are not usual for a non-governmental organization, research center or public agency. They require not only the systematization of an implementation model for the park, but also a drive for its future scalability, in the form of organizational efficiency combined with the continuous creation of value (Fiates et al., 2007; Jabbour & Fonseca, 2005; Osterwalder & Pigneur, 2011).

In this context, the future scalability of science parks refers to the application of the resource-based view (RBV), as it seeks to establish a connection between sustaining competitive advantage and developing tangible and intangible resources (Collis & Montgomery, 1995; Prahalad & Hamel, 2006).

According to Wessner (2009), some resources can affect organizational efficiency and the creation of value in science parks. These resources include: (a) tangible resources, involving financial articulation through public funding and active private participation, aligned with public policy for innovation in companies, the formalization of institutions to manage the managerial and technological maturity of the park, investments in education, and training and the definition and application of metrics to monitor the effectiveness of the park; and (b) intangible resources, including the actions of individuals committed to the development of the park, leadership to facilitate the rela-

Table 1
Organizational elements important to the managerial organizations of science parks.

Organizational elements	Description
Customers	Provision of services to resident companies that develop innovative high technology activities, some specializing in specific sectors and others with activities related to several sectors.
Value proposal	Benefits offered by the managerial organization to customers based on lower cost and/or differentiation of services and infrastructure compared with other parks as factors that attract companies to science parks.
Key activities	Main activities to meet the requirements of installed companies and attract new ones, ranging from project management to obtaining resources, technical and technological services of interest to customers, incubation, property management and maintaining physical structures.
Key resources	Resources necessary to the park's activities, classified as (1) physical (land, buildings, social areas, common infrastructure); (2) human (managerial organization team); (3) intellectual property assets of the managerial organization (patents, copyright, customer database).
Key partnerships	When no asset is available to offer a certain activity, the managerial organization can seek partnerships for this purpose, most commonly with universities or research institutes, the authorities (at several levels), business associations and funding agencies.
Financial aspects	Sources of funding for the implementation of capital goods, sources of revenue through operations (own revenues), external sources of revenue and operational costs of the park.

Source: Filioli (2013).

tionship between entrepreneurs, researchers and investors, and bonds of trust and exchanges of experiences between the professionals who operate in the park.

In general, the RBV suggests that a sustainable competitive advantage requires, in addition to the exploitation of resources, the development (investment, renewal and leveraging) of new resources (Teece, Pisano, & Shuen, 1997) or a new combination of existing resources to construct, maintain and highlight value creation. Thus, the interest in applying the RBV to the context of science parks lies in linking the understanding of organizational efficiency to the value creation over time through formal managerial processes to adapt, align and renew resources.

Thus, the aligned management of the property structure, technological cooperation and innovation services requires specific organizational management. The management of a science park differs from that of business districts, given that the challenge is to guarantee organizational and technological efficiency and create value for installed companies or start-ups and the local economy (Giugliani, 2011; Porto et al., 2007). Corroborating the understanding of this challenge, Filioli (2013) summarizes the organizational processes that are important to the managerial organizations of science parks when it comes to aligning organizational efficiency and the value creation, as shown in Table 1.

The future scalability of science parks thus depends on the operations of their managerial organizations in the systematized management of resources and organizational processes. This creates an opportunity to discuss the principles of dynamic, ambidextrous and relational capabilities.

Science parks, in addition to the management of their internal resource base, have also become mechanisms that facilitate strategic partnerships between resident companies and start-ups and external agents to share knowledge (Bollingtoft, 2012; Soetanto & Jack, 2013; Vanderstraeten & Matthyssens, 2012). Therefore, technological cooperation offers parks and their actors a chance to create value and capture it by using cooperation funds and strategic alliances as a focus for sharing knowledge (Hutabarat & Pandin, 2014; Zott et al., 2010).

Regarding the ambidexterity approach, Birkinshaw and Gibson (2004) define it as the functions for identifying opportunities (that enable adaptability) and the rationalization of resources and processes (that determine alignment), in an attempt to create more value. In other words, the ability to perceive environmental opportunities is defined by the authors as the function of adaptability, which in the case of science parks means anticipating technological paths and later seizing opportunities and meeting the needs of resident and start-up companies (Magalhães & Zouain, 2009).

The capability to identify and mobilize resources internally to take advantage of external opportunities has to do with the function of alignment. In science parks, this involves activities such as developing and expanding business plans, investment proposals, continuous managerial improvement and guaranteeing the satisfaction of actors by creating and monitoring indicators of quality and satisfaction regarding the services provided (Magalhães & Zouain, 2009).

Concerning dynamic capabilities, Helfat et al. (2007) define them as processes for creating, extending or modifying the resource base. The "resource base" includes tangible, intangible and human assets (or resources) and the capabilities of the managerial organization to control or access resources through partnerships.

Finally, examples may be highlighted of dynamic capabilities to create, extend or modify the resource bases of science parks. These include access to and the dissemination and sharing of knowledge in a wider network of relationships (inter-regional and/or multisector networks), seminars, conferences, training and technological demonstrations, transfer of technology, cooperative developments and creating new innovative businesses (Magalhães & Zouain, 2009).

Methodological procedures

The methodological approach was qualitative and the research exploratory (Yin, 2010). The method was the case study of the "implementation program and scalability of the SSP".

There were specific reasons for using a case study. The SSP is the only program in the country for the implementation and scalability of a science park with a central focus on the energy sector (oil and natural gas). The SSP will be of great importance to the national scenario in the future. Data and evidence were

collected from the actors of the SSP and managers of other consolidated parks. It is also important to highlight that the focus of the study is a contemporary phenomenon embedded in a real life context.

It should be emphasized that the "subjects" of the case in question were represented by agencies that are active in the implementation and scalability of the SSP, including the Santos Science Park Technology Foundation, the Board of Directors of the SSP and the Municipal Secretary of Development and Strategic Issues of the Municipal government of Santos.

Due to the specific aspects of the "implementation and scalability of science parks", not only were data used from agencies involved in the SSP program, but also external sources and complementary data, especially from science parks with successful implementation and scalability in Brazil, such as Tecnopuc in Porto Alegre and Porto Digital in Recife.

Semi-structured interviews were conducted with directors of the Tecnopuc Park in Porto Alegre and Porto Digital in Recife (consolidated parks in Brazil) to obtain information that would aid the structuring of the aforementioned theoretical model. Bibliographic and document research was conducted. Meetings of the municipal government in Santos were attended and information was obtained at the workshop.

The questions asked during the semi-structured interviews were: (i) What is the managerial organization of the park and its legal status? Why was this legal status adopted? (ii) What are the park's strategies for communication with other institutions (STIs, funding agencies, entrepreneurship, intellectual property) and the community? (iii) Did the park originally have a defined location for its implementation (land, building(s), reuse of abandoned/degraded areas, etc.)? Were there any property issues to be resolved? How did this process occur? Was the municipal government involved? (iv) What is the organizational structure of the park and what are its managerial mechanisms (management committee, boards, etc.)? What is the composition of the managerial committee? (v) Who are the park's domestic and international strategic partners? What is the park's anchor company? (vi) What are the value creation strategies for resident companies with a view to local development? The responses to these question resulted in a greater contribution to the structuring of the theoretical model for the implementation and scalability of the SSP, especially in terms of legal status, the managerial organization, communication strategies and property issues.

Following the data collection, the information was transcribed and prepared for analysis, interpretation and the drafting of a research report (Creswell, 1998). The analysis and interpretation of the data involved extracting meaning from texts and images. This required the data to be prepared for analysis, enabling a more in-depth understanding of the data and a broader interpretation of their meanings.

It should be highlighted that the data analysis was complemented by content analysis procedures described by Bardin (2010), at both analysis levels, i.e., the level of each interview through deciphering to understand a person's speech and at the intercommunication level between individuals through the thematic crosscutting process. Thus, the data were interpreted through categorization and coding.

Table 2
Stages of data collection.

Stages	Description
Bibliographic research	Articles and publications on domestic and international science parks were analyzed, important references for the structuring of the SSP. Important international experiences that serve as references include parks in the UK, Spain and New Zealand. Regarding domestic parks, information was analyzed on Tecnopuc in Porto Alegre and Porto Digital in Recife. Some were implemented in areas considered degraded from an urbanistic viewpoint, in situations similar to the areas earmarked for the SSP.
Document research	Various documents provided by the Municipal Government of Santos were analyzed: the portfolio of structuring projects for Santos (pdf file); institution of the Santos Science Park Foundation (SSPF) (minutes); bylaws of the Santos Technical Knowledge Foundation (minutes); and Supplementary Law 470 and amendments creating the Revitalization and Development Program of the Central Historical Region of Santos, Alegra Center.
Preparatory meeting at the Secretariat for development and Strategic Issues at the Municipal Government of Santos	At this meeting, the strategy for the workshop with the representatives of the SSP Board of Directors on 05 July 2011 was defined. The strategy consisted of defining three relevant "variables" for the current stage of discussing the implementation model and presenting and explaining them to the Board, followed by questions to obtain contributions from these representatives. The three variables were, respectively, the legal status of the managerial organization, the communication strategies of the SSP and property issues.
Workshop on the implementation and scalability model	This event included a presentation of the implementation model to the members of the Board of Directors (BD) of the park, followed by a discussion on specific topics related to the legal status of the managerial organization (SSPF), communications and property issues.
Intermediate meeting at Santos Town Hall	Held on 01 June 2011, the purpose of this meeting was to discuss matters related to the future of the park with the Municipal Secretary for Development and Strategic Issues regarding the expected strategic results.
Semi-structured interviews with science park professionals	Interviews were conducted with the directors of the Tecnopuc Park in Porto Alegre and the Porto Digital Park in Recife (online and by telephone) to obtain data on the legal status of managerial organizations, communication strategies, real estate issues, organizational process management, strategic partnerships, creating value for resident companies and local development to aid the preparation of the implementation and scalability model of the SSP.

Source: Prepared by the authors.

In Table 2, the data collection stages are summarized according to the multiple evidence in the case study, in accordance with Yin (2010).

Results: legal status, communication and property issues of the SSP

The results of the workshop attended by members of the Board of Directors (BD) of the park are given below. These are

Table 3
Legal status.

Relevant variable	Description of variable
1. Legal status	Need to change the legal status of the SSPF with the structuring of the park and the beginning of implementation and scalability actions with operational and strategic management.

Source: Prepared by the authors.

followed by comments made by the participants and new observations. Table 3 contains a description of the legal status variable, followed by a discussion of different aspects related to this variable. Observations were also made during the semi-structured interviews with the directors of some Brazilian science parks.

This subject turned out to be controversial, with one of the participants from a local university questioning it incisively and disagreeing that this subject is a matter for the managerial organization. On the other hand, another participant from the business community commented that it is understandable that the social objective of the SSPF is in its early stages and consequently a number of possibilities can be considered. However, apparently, the questions were raised because the social objective had not been defined in a forum with the involvement of the Board of Directors. The Municipal Secretary for Development and Strategic Issues commented that the bill of law for changes to the statute of the Foundation had been submitted to the local council.

As the SSP will evolve to a model similar to science parks in other countries, especially the USA, Canada and Asian countries like Malaysia and Singapore, it is possible that in its first ten years, government support will be reduced. Therefore, the park will require the involvement of the private sector (e.g., for real estate development, laboratories to provide services, etc.). In this sense, it will be necessary to identify a priori the difficulties that will be faced to enable the project to continue in the region without a public foundation, which is the legal body of the current managerial organization. This organization has to adapt to the early stages of the park, with a number of partnerships with research institutes and funding agencies having to be formalized. Considering the expanding activities of the park, one of the inconveniences is that this type of foundation has to submit to state control to achieve its goals (Instituto Prointer, 2002).

The most flexible legal status, and the most commonly used and successful for science parks in several European countries, is that of a corporation, as the owner of property that it administers using business criteria and accountable to a Board of Directors, with representatives of the institutions that maintain the park. A majority share in the capital of the corporation is traditionally held by the institution that makes the highest contribution to the park's maintenance. Overseas experience indicates that it does not seem to be convenient to have representatives of business associations or representatives from the park's companies on the Board. It should be remembered that the Board is the highest authority, with legal responsibility, and should maintain strategic criteria for long-term regional and local development. These criteria are not always well understood by entrepreneurs, whose private interests are generally more in the short term. The creation of other organs such as Advisory Councils and Urbanism Councils is a more suitable method for involving other agents (Instituto Prointer, 2002).

There are two alternatives to evaluate when considering the future need for change in the legal status of the management unit (SSPF):

(i) The members of this management unit, as founding partners, establish a new private, non-profit company, with administrative and financial autonomy and autonomy over assets (social organization). The internal statute would regulate the rights and duties of the members and the structure and functioning of the organization to seek a "mixed solution" involving: (a) the use of the public foundation (SSPF) to manage the capital goods (land, space in public buildings, use of public equipment, attraction of public investments, etc.); and (b) the use of the private, non-profit company to handle service contracts, the relationship between company and university and attracting private investment to the park, etc. This organization would be important especially during the phase of introducing companies to the market and the internationalization of the park (Instituto Prointer, 2002). Porto Digital, as a social organization, does not suffer discontinuity in its activities with changes in the government because its managerial nucleus (the Porto Digital Managerial Nucleus (PDMN)) and its projects can be managed without government financial aid or intervention (Pereira & Horiguchi, 2009).
(ii) A corporation called the Santos Science Park S/A is established, with a local development agency (LDA), for example, (in this case, it would need to be created, a difficult task from a political viewpoint) as the major shareholder. Its shares would be paid for through the donation of the science park's land (adapted from Instituto Prointer, 2002). LDAs are generally formal or informal agencies created with the help of the public sector (Federal, State or Municipal) to promote the development of a certain territorial zone. However, they are not necessarily the exclusive property of the state. They have a number of instruments (e.g., information systems, services to assist local companies, etc.) and a significant level of managerial autonomy. Furthermore, they are articulated with other existing instruments in the region, the state, the country or overseas (e.g., research institutes, federal and state agencies, banks, development funds, etc.), guiding them in concrete, socio-economic actions to create dynamism in their territory (Instituto de Pesquisas Tecnológicas do Estado de São Paulo, 1996).

In any of these cases or in another scenario that might emerge, it is fundamental for the management of the science park to be guided by business criteria.

In replies to the questions on the SSP communication strategies (Table 4) (i) What do you think of this idea? and (ii) What else will be needed for the Animation Program to spread the "innovation culture" among the various segments of the population and show that the park will be open to innovative

Table 4
Communication strategies.

Relevant variable	Description of variable
2. Communication strategies	Publicity strategy of the science park and its links to the community to make it inclusive regarding initiatives related to all vectors of development.

Source: Prepared by the authors.

Table 5
Property issue.

Relevant variable	Description of variable
3. Property issue	Need for future partnership of the SSPF and a private master developer to decide which land and buildings will be made available to technology-based companies and start-ups attracted to the park.

Source: Prepared by the authors.

initiatives from different development vectors of the region?, the participants at the workshop highlighted that before the Secretariat of Development and Strategic Strategies of the Municipality adopts any communication and marketing strategy, it is imperative to define clearly the areas that will effectively come within the scope of the SSP. In this sense, it is necessary to define the focus of its operations, concentrating on some sectors, e.g., oil and gas and information technology. Regarding the field of oil and gas, it was highlighted that communication and publicity should begin immediately, as the companies in this field have already expressed an interest in setting up business in the city.

In answer to questions on the property of the SSP (Table 5) (i) *on which bases could this partnership be formed?* and (ii) *what political and institutional arrangements will be required?* The participants at the workshop highlighted the need to gauge how these matters have been addressed at science parks in other countries, revealing their lack of knowledge of these parks.

Unlike some science park initiatives overseas, at the Porto Digital and Tecnopuc parks, no partnerships were observed with private real estate development agencies to implement activities and make them more dynamic.

In the initial phase of the Porto Digital Park, the interaction between its managerial nucleus (PDMN) and the state government was decisive to revitalize the suburb of old Recife, where the physical installations were located. Moreover, public investment was a determining factor in the acquisition of buildings to house the NGPD, the Recife Center for the Study of Advanced Systems (CESAR), the first companies "housed" there and all the necessary infrastructure for these organizations to function (Pereira & Horiguchi, 2009).

Tecnopuc has an operations strategy with buildings and land in Porto Alegre, which was made possible by resources from PUC University of Rio Grande do Sul (PUCRS) (Fundação Centros de Referência em Tecnologias Inovadoras, 2005).

Discussions on the implementation and scalability of the SSP

The project to implement the SSP is run by the Santos Municipal Government, although it has the characteristic of an asset for regional innovation. The SSP is multisector in nature, based on the articulation of the main development vectors selected for the region, i.e., energy, logistics, tourism, urban development, R&D, the environment, port industry and fishing (Lara, 2001).

An actor that will be responsible for the general direction of the park is the Santos Science Park Foundation (SSPF). Its creation was determined in a bill of law passed by Santos Council. It is a public, non-profit entity that will operate as an Agency for Innovation and Competitiveness (Santos City Hall, 2011). The Board of Directors (BD), Technical Board (TB), Executive Board (EB) and Management Board (MB) of the SSPF are described below.

Twenty representatives of organizations and institutions in Santos were appointed to the BD of the SSPF, including universities, the Trade Association, Petrobras, Usiminas, State Government and Ministry of Science and Technology. The Board will deliberate matters related to the social objective of the SSPF and consult its members.

Initially made up of researchers involved in the thematic areas of the park, the TB later included representatives from universities in the Santos region. This Board, which now has 15 representatives, will be responsible for training and qualifications, including setting and evaluating the content of future courses and training at the park. It should be highlighted a priori that these courses and training will always be aligned with the expectations for the innovation of the sectors defined as development vectors in the region.

The composition of the BD and TB will change according to the structuring requirements of the park. The Chamber of Programs and Projects (not yet established) may be made up of researchers and academics (including members of the BD and TB) and will be coordinated by the Executive Board of the SSPF.

The EB will have a president and members of the TB. Later, this Board may be subdivided into the Technical Board and Governing Board. In the initial activities of the park, its staff will probably have to be funded by the Municipal Government. In turn, the Higher Council of the Organization of Civilian Private Society (OS) may be composed of a group of notables from São Paulo State, i.e., well-known figures in the scientific, business and political communities.

The MB will have representatives from government agencies and civilian society who will be in charge of the park's development and future internationalization. The Technical Committee for the Evaluation and Monitoring of Programs and Projects may be made up of a multidisciplinary team of specialists, as it will have to ensure that the programs and projects developed at the park are technically consistent and aligned with the park's vision and mission. Finally, the EB of the OS will be composed like the SSPF, as they will almost be "sister entities".

As Porto Digital is one of the benchmarks for analysis regarding the SSP implementation model, it is important to stress

the legal status of the park as a private corporation. This status was adopted because the park's creators foresaw a change in the profile of the park's companies and strategies (e.g., internationalization of businesses) within a few years. According to Amorim and Dornelas (2005), the transition from innovative technology-driven organizations to market-oriented organizations already appeared to be taking place at Porto Digital five years ago. In the view of the authors, this change in focus was deemed essential for the growth and consolidation of the cluster of innovation in information technology (IT). With initially heavy funding from the State, the cluster gradually moved to consolidate its companies in the market. An apparently important factor in the articulation of mechanisms for these companies to seek market orientation was the legal status of the PDMN as a social organization.

Taking Porto Digital as an example once again, a number of actors could be involved in the SSP and interact with the SSPF, especially universities and technical schools, science and technology research institutes, specialist laboratories providing technical services and technology-based anchor companies. Other actors include companies that use products and services with intensive scientific and technological knowledge, offices specializing in knowledge transfer, project hotel (pre-incubation), technology-based incubator start-ups, business schools, technology centers and public and private R&D centers (Instituto de Pesquisas Tecnológicas do Estado de São Paulo, 2007).

In this sense, the evolution of the park will require of the SSPF, which will be at the center of this process, great capacity for articulation among the actors to put several plans, programs and instruments into action that will help to achieve the goals of the park. Furthermore, some activities that the management unit will be involved in during the coming years include intellectual property and technological transfer, facilitating relationships between companies and investors and between universities, companies and STIs. Other activities include networking and international cooperation, admission of companies and lines of business (sale of real estate, service provision, etc.). The unit will also be involved in relationships with the community and seeking resources and funding (adapted from Instituto Prointer, 2002).

As the SSP will be able to evolve to a model similar to international science and business parks, especially those in the USA, Canada and some Asian countries (Malaysia, Singapore), it is possible that in the first fifteen years there will be less government support. Therefore, the park will require the involvement of the private sector (real-estate development, laboratories for providing services, etc.). In this sense, it will be necessary to identify a priori the difficulties that will be faced to allow the project to continue without the direct support of a public foundation, which is the legal entity of the management unit that best serves the early stages of the park. It is inconvenient that this type of foundation has to submit to state control to achieve its aims.

In this situation, it may be that for the future scalability of the SSP, a mixed solution will be used (Y Model in Fig. 1), involving the use of the public foundation to manage the capital goods (land, spaces in public buildings, use of public equipment, attracting public investments, etc.). Meanwhile, contracts to provide services, the relationship between company and university, etc., would eventually be handled by a private non-profit organization. The functions of this organization could include attracting investments to the park.

Meyer-Stamer (2000) stresses that for the future scalability of a science park, the availability of land is fundamental for the initial structuring of the venture. This is followed by support activities for the companies that will reside in the park and support to attract new companies, in addition to marketing to promote the image (brand) of the initiative. Alongside these comes the creation of entities, support mechanisms and existing activities for start-ups or companies in crisis. Finally, conditions are created to integrate the park's activities, such as Local Agenda 21, and other initiatives intended to promote economic activities and other activities in the region (Fig. 2).

Therefore, in accordance with Meyer-Stamer (2000), the implementation of the SSP should begin with the granting of land, i.e., a real estate project, defining the land and buildings that will be provided for anchor and start-up companies and the buildings and locations for research centers and support services. Mechanisms for the expropriation of buildings and land by the state and municipal government will also have to be analyzed in this context.

It should be highlighted that before the granting of land, it will be necessary to articulate political, social and economic activities. The most important political activities that will have to be addressed by the park include defining criteria for the use of land by companies and institutions interested in residing in the park and the establishment of criteria for the incubation of companies. This includes policies for relationships with the future incubator (pre-incubation and incubation) and the relationship that will be established between the SSPF, support services, consultancies, training centers, etc., and the units of the future park (laboratories specializing in providing services, incubator, park management office, etc.).

In addition to these political activities, the implementation project of the SSP will also include economic activities, such as defining mechanisms for collecting fees for the use and occupation of the park's land. Another issue to be addressed is the managerial agencies' share of the fees charged for the services provided by the laboratories, which also include the use of the facilities of the park's Technological Center and fees for specific services. In general, this corresponds to how the financial and administrative aspects of the park will be handled (cash flow) from the structuring of the technological center to its development and expansion (in this case based on an ideal scenario). This is done to evaluate when the initial and other investments that will be made during successive phases of expansion of the park will be recouped and when this, in turn, will begin to generate a profit and benefits for society (innovation, jobs, etc.). Establishing mechanisms for receiving royalties from graduate companies has also been a strategy adopted by some parks around the world, especially high-technology American science parks. The basic constitution of the park will include the SSPF, research centers, technology-based incubator and laboratories specializing

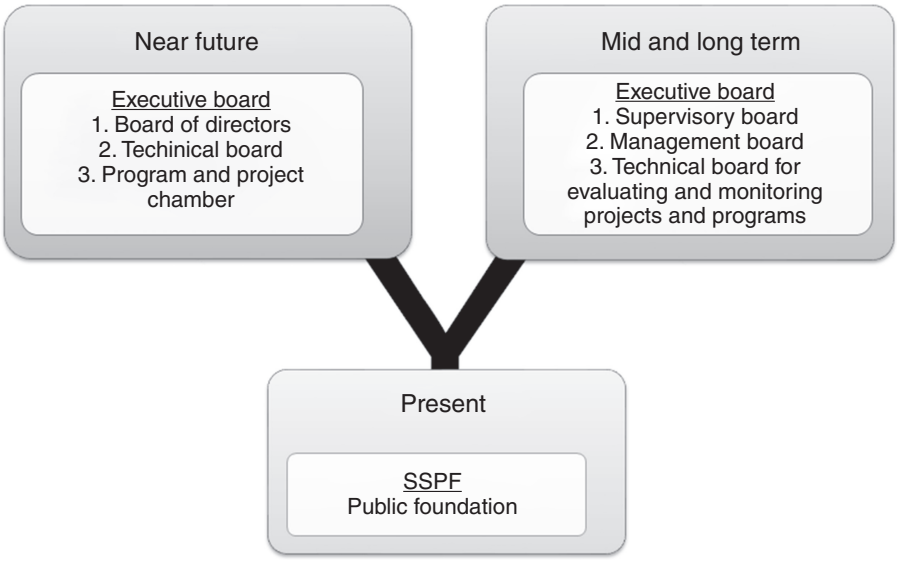

Fig. 1. Proposed Y Model for the implementation and future scalability of the Santos Science Park, emphasizing possible legal actors.
Source: Prepared by the authors.

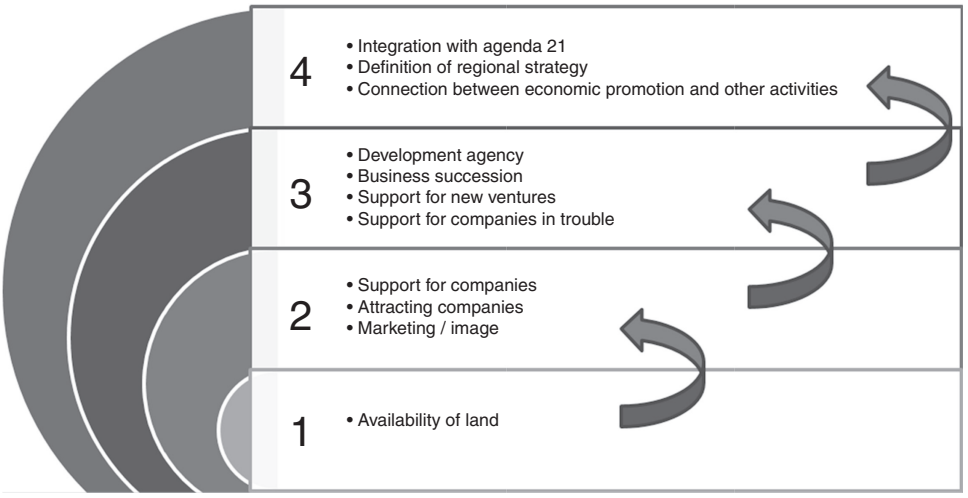

Fig. 2. Economic promotion process forged by a science park.
Source: Adapted from Meyer-Stamer (2000).

in fields considered vectors of development (oil and gas, IT, etc.).

In addition to political and economic activities, the implementation project should also include social activities regarding the relationship between the park and external segments and actors at the local, regional and international level, including public authorities, associations and companies.

After the development of the political, economic and social activities involved in the implementation of the park and having concluded the real estate project, the management unit should create efficient mechanisms as part of its marketing plan to attract and retain companies. This can be aided by the publicity that the Santos lowlands have enjoyed because of the oil and natural gas in the pre-salt layer. Support for the development of cooperative projects involving companies and public institutions with a view to the technological adaptation of products or incremental innovation of products and processes is another initiative that can create new ideas, products and start-ups for the park. A point in question is the sector networks that have been created in the field of oil and gas. Some of these are related to navigation and are important means of attracting companies and projects involved in technological development.

Specifically regarding the future scalability of the venture, i.e., the drive for organizational efficiency associated with creating value, the management unit should channel its efforts to the internal management of tangible and intangible resources, as reported in the interviews and reinforced by the theoretical principles of Teece et al. (1997) and Wessner (2009).

Therefore, the SSP management unit should consider actively managing its internal tangible resource base, including financial articulation with public funds and active private participation aligned with public policies for innovation in resident

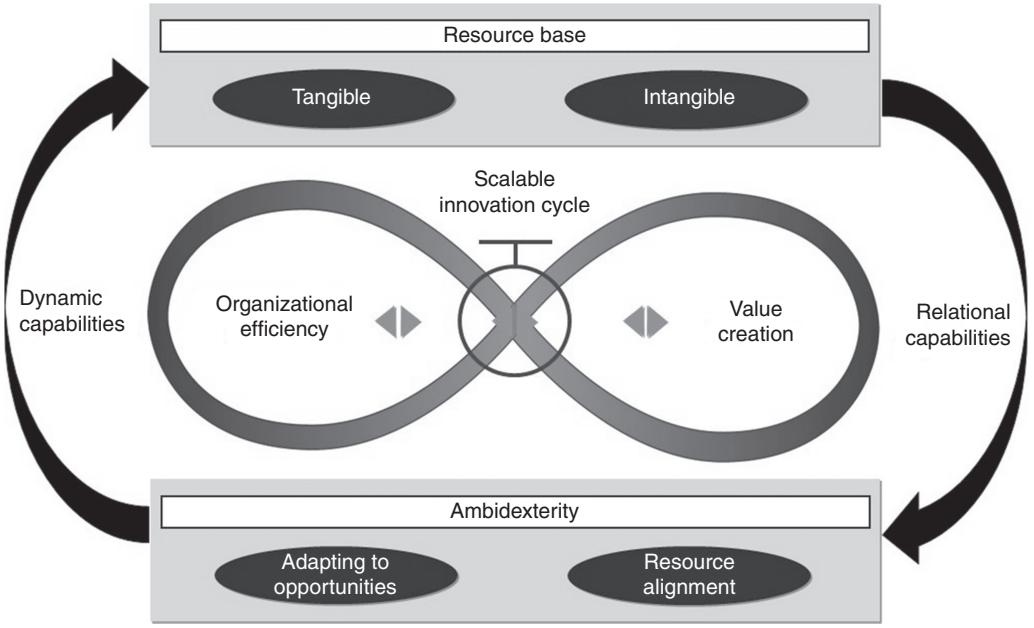

Fig. 3. Scalable innovation cycle of a science park.
Source: Prepared by the authors.

and start-up companies. They should also consider formalizing institutions to manage the managerial and technological maturing process of the park and achieve investments in education and training. Another point is creating and applying metrics for monitoring the effectiveness of the park. The management of the intangible resource base should also be highlighted. This involves the actions of individuals committed to the development of the park and leadership to facilitate the relationship between entrepreneurs, researchers and investors. It is also important to consider bonds of trust and the sharing of experiences by the professionals involved in the park.

Another important aspect for the scalability of the SSP is the development of dynamic capabilities to create, extend or modify the internal tangible and intangible resource base. This will simultaneously require the adaptation of opportunities and the alignment of formal managerial practices. This synergy was demonstrated in the interviews and supported by the theoretical approaches of Helfat et al. (2007), Birkinshaw and Gibson (2004) and Magalhães and Zouain (2009).

Thus, the SSP should consider the possibility of developing dynamic capabilities to create, extend and modify the resource base through access to and the dissemination and sharing of knowledge in a network of relationships and at seminars, conferences and through training and demonstrations. This can also be done through providing technological services, technology transfer, collaborations and the creation of new innovative businesses. The park should also evaluate the possibility of developing ambidextrous capabilities for adaptation and alignment, as the function of adaptation means anticipating technological paths that will lead to opportunities. It also means meeting the needs of resident and start-up companies. Alignment involves the development and expansion of business plans, investment proposals, continuous improvement in management and guaranteeing the satisfaction of those involved by creating and monitoring quality and satisfaction indicators for services provided.

Finally, the scalability of the SSP should foresee the development of relational capabilities to create value in accordance with the theoretical principles of Bollingtoft (2012), Soetanto and Jack (2013) and Hutabarat and Pandin (2014). In other words, the park and its stakeholders should prioritize collaboration in multiple spaces and contexts for innovation (internal and external). These spaces include offices, laboratories, training centers, fairs, conferences, local communities, government programs, associations, thematic and export networks and working with end customers. Thus, as the managerial units and resident and start-up companies work together, they come to belong to and become involved in a collaborative reality that reaches beyond the physical limits of the park, creating value with renewed relational capabilities.

The gradual development of the park's relational capabilities will also mean dynamic collaborative projects between multiple institutions, involving research centers and laboratories in different regions, with parks seeking to optimize their infrastructure for offering technological services and specialist technical services. Achieving these projects could consolidate thematic research networks that could be accredited as the SSP's Science and Technology Institutes (STIs).

From these discussions, a theoretical model was proposed for the convergence of the processes of implementation and scalability of a science park through a scalable innovation cycle, supported by organizational efficiency and value creation. The details are shown in Fig. 3. Therefore, the following theoretical proposal can be made: (P_{01}) *The alignment of the implementation and scalability processes of a science park can*

Table 6
Processes and activities for the implementation and scalability of a science park.

Processes	Activities	Description
Implementation	Definition of the action	Multisector, including energy, logistics, tourism, urban development, R&D, environment, port industry and fishing.
	Legal format of the managerial organization	Legally registered non-profit public agency that will operate as a learning and research institution and Innovation and Competitiveness Agency. For the future, possible mixed solutions may be found involving the use of public funds for the management of capital goods, such as contracts to provide services, and the relationship between university and company might be brokered by a private non-profit agency.
	Political activities	Definition of criteria for the use of land and incubation for companies and policies for relationships with units of the future park (laboratories specializing in services, incubator, consultancies, qualification centers, park management office, etc.).
	Economic activities	Definition of mechanisms to charge for the use and occupation of park property and the share of managerial agencies in the values received for services provided by the laboratories, including the use of the Technological Center of the park and fees for specific services.
	Social activities	Analysis of the relationship that the park will have with various sectors and external actors at the local, regional and international level, including public authorities, associations and companies.
	Real-estate project	Decisions regarding real estate and land made available to anchor companies and start-ups, buildings and spaces for R&D centers, support services, expropriation of buildings and land by municipal and state authorities.
	Attracting and securing companies	Implementation of marketing plan due to the visibility of oil and natural gas in the pre-salt layer in the Santos region, with support for the development of collaborative projects in the thematic networks of oil and gas, involving companies and public institutions for the technological adaptation of products or incremental innovation in products and processes.
Scalability	Management of internal tangible resource base	Financial articulation with public funding and private participation, aligned with public policies for innovation in resident and start-up companies; formalization of institutions to manage the managerial and technological maturity of the park; investments in education and training; and defining and applying metrics to monitor the effectiveness of the park.
	Management of intangible resource base	Actions of individuals committed to the development of the park, leadership to facilitate relationships between entrepreneurs, researchers and investors and bonds of trust and exchanges of experience among professionals.
	Development of dynamic capabilities	Access to, dissemination and sharing of knowledge in a relationship network, seminars, conferences, training and technological demonstrations, provision of technological services, cooperative technological development projects and creation of new innovative businesses.
	Development of ambidextrous capabilities	Foreseeing technological paths, recognizing opportunities and the needs of resident and start-up companies (adaptation function); later development and expansion of business plans, investment proposals, continuous improvement of management and guaranteeing the satisfaction of parties involved by creating and monitoring quality and satisfaction indicators for services provided (alignment function).
	Development of relational capabilities	Prioritizing collaboration in multiple spaces and innovation contexts (internal and external), such as offices, laboratories, training centers, fairs, conferences, local communities, government programs, associations, thematic networks, technological and export consortia and final consumers to make projects dynamic, cooperative and multi-institutional to consolidate thematic networks and, in the future, be accredited as Science and Technology Institutions (STIs) of the SSP.

Source: Prepared by the authors.

be considered a scalable innovation phenomenon, supported by organizational efficiency and value creation.

In specific terms, it can be concluded from the representation of the model (Fig. 3) that the implementation process of a science park requires not only a legal status and adequate real estate project, but also involves the articulation of political economic and social activities that precede the implementation of the venture proper. These activities include defining the criteria for the concession and use of the park's infrastructure and services and the mechanisms for the economic and financial support of the park and social regulations that will affect its relationship with resident and non-resident companies and society. This is in accordance with the theoretical principles of Doz and Kosonen (2008), Kanter (2009) and Henderson and Newell (2011). Therefore, the following theoretical proposal can be made: (P_{02}) *The awareness of a political, economic and social context is an antecedent for the implementation of a science park.*

Once the real estate project has matured and the political, economic and social activities have been aligned, the science park should then consider initiatives for evaluating the internal tangible resource base (articulation and expansion of investments and managerial and physical structure) and the intangible resource base (articulation and expansion of commitment, leadership and trust). This corroborates the findings of Prahalad and Hamel

(2006) and Collis and Montgomery (1995) (Fig. 3). Therefore, the following theoretical proposal can be made: (P_{03}) *The active evaluation of the internal tangible and intangible resource base is a managerial strategy of the implementation and scalability of a science park.*

This active evaluation of the resource base requires the development of relational capabilities. In other words, the search for external partners to exploit and absorb knowledge that was previously unavailable in the park's internal resource base. This is in keeping with the theoretical principles of Zott et al. (2010) and Hutabarat and Pandin (2014) (Fig. 3). Thus, the following proposition can be made: (P_{04}) *Exploiting and absorbing external knowledge is a conditioning factor in the implementation and scalability of a science park.*

Having established partnerships, the management unit of the park should then adapt the knowledge absorbed to seize opportunities and meet the needs of residents companies and later promote the expansion of its business plan. This requires ambidextrous capabilities in accordance with Birkinshaw and Gibson (2004) (Fig. 3). Therefore, the following theoretical proposition can be stated: (P_{05}) *The functions of identifying opportunities and the rationalization of resources and processes in an attempt to create value are conditioning factors that affect the implementation and scalability of a science park.*

Finally, the park will promote the development of dynamic capabilities as postulated by Helfat et al. (2007), with a view to creating, extending or modifying its knowledge and experiences in a broader network of relationships. This will include providing technological services, technology transfer, continuous development of collaborative technological projects and creating new innovative businesses (Fig. 3). Thus, the following theoretical proposition can be made: (P_{06}) *The processes of creating, extending or modifying a resource base consequences of the implementation and scalability of a science park.*

Final considerations

The aggregate results of the study enabled the proposal of a theoretical model for the implementation and scalability of a science park through the development of dynamic, ambidextrous and relational capabilities.

In specific terms, it should be highlighted that the coordination of multiple local actions related to the development vectors of Santos and its lowland region requires a difficult interaction process involving a number of actors. With the implementation of the SSP, an instrument for development that could influence and provoke changes in the economic logic of the region, the level of interaction between actors would have to increase. This might lead to greater conflict between them, but could also create opportunities for regional improvement. In this sense, the management unit of the SSP will have to reflect on certain key activities of the implementation process and scalability. These include defining and converging the park's fields of operations, considering the scientific and technological vocation of the region. Another activity is the legal status of the management unit with a view to a mixed solution (private and public). Another key point is awareness of the political, economic and social context of the region where the park will be installed and actions to attract and retain companies. Inclusion in technological cooperation networks is also important to create and obtain value in collaboration, using cooperation funds and strategic alliances, adapting knowledge to create opportunities and meet the needs of resident companies, promoting the realignment and expansion of the park's business plan.

Regarding the contributions, Table 6 highlights the processes and activities for the implementation and scalability of a science park. However, it is important to emphasize the need for due caution on the part of institutions interested in managing science parks.

Regarding the limitations of the present study, it is necessary to consider the issue with due caution, as it is not possible to make sweeping generalization regarding the results, as these are explicitly related to the cases in question, including the Santos Science Park, the Tecnopuc Park in Porto Alegre and the Porto Digital Park in Recife.

Considering proposals for future studies, it would be interesting to conduct a comparative analysis of the proposed governance model in science parks in emerging economies such as Brazil, China and India.

Conflicts of interest

The authors declare no conflicts of interest.

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