A technology park with a triple helix trajectory: Tecnosinos- São Leopold's technology park (Brazil).

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Abstract

This paper analyses, through a case study method, the genesis and management of an award-winning, private, and university-linked technology park. The analysis is under the lens of the ten Cabral-Dahab criteria paradigm and the Triple Helix paradigm. In addition to confirming the park's triple helix trajectory (University - Organized Private Sector – Government) and the combination of both paradigms as an appropriate model for a developing country, specific situations were also found in the areas of park management and the university's curriculum in relation to electronics and information technology, that contribute to the development of the São Leopoldo region (Brazil) based on the knowledge economy. Further aspects of knowledge related to the Cabral-Dahab paradigm criteria are mentioned.

Keywords: *technology park, triple helix, Cabral–Dahab paradigm, government, university, firms, regional development, Tecnosinos - São Leopold, Brazil, park management, university curriculum, knowledge economy, appropriate model, park's triple helix trajectory, private university.*

Introduction

The last 60 years have seen the development of many Science & Technology parks, following the creation of *Silicon Valley*. In the US, the Stanford science park was the result of an incubation process that had begun decades earlier within the university and served as a location for firms that wished to keep close ties with their source of origin (Etzkowitz, 2002). Nowadays almost every city of a certain size and importance (especially those with at least one college) has a science and/or technology park (IASP, 2015) that can contribute to achieving a certain level of institutional organization in that city or region. This allows innovation systems like the Triple Helix to achieve a sustainable urban transformation (Zouain and Plonsky, 2015) and to reconcile the three dimensions of sustainability: social, economic and environmental (Veiga and Magrini, 2009). Science parks represent a popular policy tool to enhance knowledge-based regional development (Van Geenhuizen and Soetanto, 2008).

Science and/or Technology Park (STP)[1], is a term used to describe different attempts to promote the development of entrepreneurship through the establishment of knowledge-based companies. The main goal of a STP is the conjunction of the economic and intellectual resources of a region, in order to improve and maximize the business conditions of existing companies and concentrate knowledge in one place.

In Brazil, a "meta-innovation system" emerged (Etzkowitz, de Mello & Almeida, 2005) with the constitution of the National Council for Scientific and Technological Development (CNPq) in 1951. At the beginning of the 1980s, CNPq supported the creation of technological innovation offices (so-called Nuclei of Technological Innovation or NITs) at universities and research institutes to promote innovation and encourage transfer to industry. In 1984, CNPq established twelve science parks around the country, in cooperation with state and municipal governments and universities. In 1987, as a result of an informal change of experiences for evaluation purposes, the park directors set up a civil society organization – The National Association for the Promotion of Entities of Innovative Entrepreneurship (ANPROTEC). However, a continuing economic crisis during the eighties led to the dissolution of the NITs and abandonment of the science park program even though some science parks continued with local support. Under these circumstances, ANPROTEC shifted its focus to promoting incubators. With the spread of the Internet bubble to Brazil at the dawn of this century, the growth of the incubator movement sparked a renewed interest in the establishment of science parks that included an incubator, as well as spin-off and corporate R&D labs. Good incubation practices and lessons learned were drawn from incubators in some developing countries (Lalkaka, 2003 and 2002).

A study published by The Support Center for Technological Development (CDT/UnB, 2014) reported 80 park initiatives— 24 in the project stage, 28 being implemented and 28 already in operation— spread throughout the country's regions, with the greatest concentration in the southeast and south. This is probably due to the concentration of the academic technical-scientific production in the area, as well as its industrial and economic importance (Severo *et al*., 2011). According to *The Gaucha Network*

[1] The term "Science Park" is more frequent in Europe, while the term "Research Park" is more frequent in the USA, and the term "Technology Park" is more frequent in Asia (Link and Scott 2007, p. 661). The rest of this document will use SPTs indistinctly as a generic term that includes all types of initiatives.

of Business Incubators and Technology Parks (REGINP, 2014), in 2014 the region had twenty incubators and nineteen technology parks (four consolidated and fifteen in the implementation phase). The emergence of technology parks in Rio Grande do Sul (RS) was mainly a consequence of the *Porto Alegre Technopolis* Program. Launched in 1995, it was created with a local and regional development approach, through coordinated actions from nine different institutions representing the government, the academy, labor organizations (unions), business organizations and civil society. These associates have invested in the development of a business culture in their institutions and have worked vigorously to create an adequate innovation environment (Zen and Hauser, 2005).

The main goal of this research is to verify, through a case study, how an award-winning technology park has been managing the criteria of the Cabral-Dahab paradigm (Cabral, 1998a, 19998b). This paradigm has been used to evaluate science parks, technology parks, business incubators and other similar organizations (Cabral, 2004; Cabral y Dahab, 1998). First of all, the criteria formulated in the Cabral-Dahab paradigm are presented as theoretical propositions, prioritized by Sanni, Egbetokun and Siyanbola (2010), for a successful technology park. Subsequently the foundation and historical evolution of Tecnosinos are analysed, then the progress of the park is examined based on the ten criteria of the paradigm. Finally, we elaborate conclusions in relation to these criteria in order to have a better knowledge basis of an important part of the system mentioned above.

1. Method

Given the declared objective of this work, we determine to elaborate a single case study investigation of Tecnosinos: Technology Park of São Leopoldo, and the management-interaction provided by The University Do Vale Do Río Dos Sinos (UNISINOS), which identifies itself as a "research university" (Altbach, 2009), and an "entrepreneurial university" (Clark, 2006). Tecnosinos has a total area of 250,000 m2, where 75 companies coexist, working in diverse market segments. Most of these companies work in the area of information technologies (Jornal VS, 2013; Kakuta, 2010). Tecnosinos is located in the municipality of São Leopoldo, in the metropolitan region of Porto Alegre, Brazil. The development of Tecnosinos has occurred due to the participation of a variety of actors. The most critical start-up phase happened some time ago, and the park is currently in the mature

phase (Kirk and Catts, 2004). The technology park chosen for this research is near Porto Alegre, Brazil. Tecnosinos was awarded "The Best Technology Park of 2010" by ANPROTEC and also took second place in the "Best Science - Based Incubator 2011" list, by The Technopolicy Network.

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Data collection for the case study was conducted using the six sources of evidence mentioned by Yin (2009): documentation, file records, interviews, direct observation, participant observation (in meetings) and physical artifacts (structure), all with a view to triangulating the data for purposes of validating the content of the information gathered. 19 in-depth interviews were conducted, with executive managers of Tecnosinos and the Incubator of Technology-based Companies (Unitec) (five) and staff from support structures for entrepreneurship and innovation as well as research from the UNISINOS (seven). In addition, incubated business executives (two), park residents (two) and students (three) participating in the various university entrepreneurship and innovation programs were interviewed. Secondary data were obtained through internal documents provided by the various agencies of both the park and the university, as well as their respective websites. Historical data were collected from journals, books and dissertations.

Data were organized and analysed utilizing the content analysis method (Bardin, 2002), performed in three phases: pre-analysis, material exploration and treatment of the results. Pre-analysis is the phase in which initial ideas are organized and systematized producing the choice of documents to be submitted to analysis as well as the formulation propositions – these were based on the model proposed by Sanni et al., (2010). Material exploration involves both coding and semantic categorization operations, based on previously formulated rules. Treatment, inference and interpretation of data occur when the elements are treated so as to be significant and valid. The decoding and interpretation of the findings were defined by semantic categories, classified after the transcription of the interviews for thematic analysis.

2. Prioritized Cabral-Dahab paradigm for the Management of a Technology Park

Sanni et al. (2010), reorganized and prioritized the "Cabral-Dahab Management Paradigm." Their model includes a four-phase development process of a STP: launch,

growth, maturity and diversification (Kirk and Catts, 2004); and three critical groups of actors: determinants (the staff/decisive political management level institutions), reactors (the ones involved in the location, preparation, construction, management and expansion of the park) and executors (the ones who manage the products of the park, which can be the commercialization of high-tech products and services, technology transfer, indirect knowledge, spin-offs and innovations). In Table 1, the points are listed in order of importance together with the actors (in brackets) who will organize and execute each of the operations at each stage of the STP development. This STP involves a unique situation and its success will depend on a complicated mix of local factors related to its location, stakeholders, history, business model and governance. STPs are generally multistage projects that take 15-20 years to come to maturity and possibly longer to full build-out for larger projects. For most STPs, development appears to be an essentially four-phase process (Kirk and Catts, 2004: 42):

- *Start-up: during this phase, the park is planned, support is obtained from stakeholders and funds are raised for the early growth phase. This can sometimes take years to complete. The park may have some limited premises during the start-up phase while "proof of concept" is undertaken.*
- *Growth: this phase usually involves the construction/acquisition of buildings suitable for multi-occupancy. This is the stage when the park's management and organizational structures evolve.*
- *Maturity: this phase usually sees the park settling down to a steady (if not spectacular) rate of growth with little organizational change. Some parks stop development at this phase while others continue to evolve.*
- *Diversification: in this phase the park adopts wider roles which may include, for example, developing other indirectly associated sites, getting further involved in soft infrastructure development and participating in regional or national programs. While the park's physical "hard infrastructure" may appear constant, this phase may well see [a] significant organizational development.*

Four trajectories lead to four possible different sub-models $(SMx)_{x=A,\ B,\ C,\ D.}$ depending on who has control on the decisive political directives level. The sub-models are: SmA (government trajectory), SmB (university trajectory), SmC (organized private sector

trajectory) and SmD (Triple Helix trajectory). A critical evaluation of the sub-models reveals that the Triple Helix trajectory, in which government, industry and university/research institutes are involved jointly on the decisive political directives level, is the most appropriate for a developing country.

==== Table 1. Suggested in this position ====

3. The case of Tecnosinos

Let us consider the genesis and developments of Tecnosinos from the perspective of the prioritized Cabral Dahab Park Management Paradigm (ten criteria), through its phases driven by different types of actors. According to Sanni et al. (2010), determinants have influence on criteria 1, 2, 3 and 4. Reactors during the start-up phase are involved in the fifth and sixth criteria, and in subsequent phases, in the seventh and eighth criteria. Executors during the growth phase make contributions to the eighth, ninth and tenth criteria.

Determinants: The personnel/institutions at the level of "decisive policy direction"

1. Tecnosinos has had the backing of powerful, dynamic and stable actors throughout its trajectory, from its start-up as a Pole to its growth phase. In the start-up phase, it all started with movements made by different actors and organizations to transform the technological development in the region of Porto Alegre. Lunardi (1997) notes that, in 1993, the government of Rio Grande do Sul organized a mission to different European institutions to observe the development of technology parks. Of the institutions it visited, the most distinguished was the Technological Center of Grenoble in France, whose activities represented within the urban area of this city what Spolidoro (1997) conceptualized as an "innovation habitat". As a result of this first mission (a second one was made in 1995) a number of French consultants were hired to advise on the implementation of the *Porto Alegre Technopolis* plan. Initially the project was characterized by four regions of technological potential, each one with a defined technological niche according to its infrastructure and/or the awareness of its stakeholders and its development tendency (Lunardi, 1997). One of them

– São Leopoldo, specializing in the development of information technologies – was taken on board by UNISINOS as a first step toward what Tecnosinos is today. According to several documents (ACIS 2013; Jornal VS, 2013; Sydow, 2012) and interviews with different personalities, this led to the next genesis of Tecnosinos:

The first signs date from March of 1993, when Siegfried Koelln, a member of the Young Entrepreneurs of the Association of Commerce, Industry and Services of São Leopoldo (ACIS/SL) and also director of the SKA company, asked the city government for tax-exemption status and this matter became part of the city's executive agenda. On August 5 of that same year, the prefect Waldir Schmidt approved Law nº 3874, which exempted informatics companies from *Taxes on Services of Any Nature* and the Property and Urban Territorial Taxation until 31/12/1998.

The "Informatics Pole of Sao Leopoldo" project (the Pole) was originated when a group of entrepreneurs from San Leopoldo, led by the president of UNISINOS, visited incubators under development at the University City (Ilha do Fundão) of Rio de Janeiro. From that mission, a work plan was established for the inception of the Pole of San Leopoldo.

It was in October of 1996 when a new interaction process began, between a corporate group specializing on the field of information technologies that was interested in establishing a presence near the university, and the ACIS/SL, looking for the collaboration of the city of São Leopoldo and from UNISINOS. In May of 1997, it was determined which organizations would be associated with the project and they started holding the Pole's first meetings and conducting feasibility studies. The municipal government approved Law Nº 4368, which extended the period of tax incentives, while UNISINOS announced the implementation of UNITEC and a condominium of enterprises on an acquired property of 5.5 hectares, attached to the campus. The city council expropriated 36,589.29 m^2 of land next to UNISINOS to deploy the Pole and carried out a modification on their master plan, reserving the area exclusively for technology activities.

The Pole was officially established with the enactment of Law Nº 4420 on 31/10/1997; it consisted of a business incubator, a condominium of enterprises and the technology park. The local government was authorized to donate the expropriated land to ACIS/SL and to make an endowment of modules for information technology companies associated with the Association of Brazilian Software and IT Service Companies - RS

(ASSESPRO/RS), in order to implement the Pole. Also, the Informatics Pole Council was created, with representatives from the organizations associated with the project, including ACIS/SL, UNISINOS, ASSESPRO/RS, the Information Technology Companies Association of the State of Rio Grande do Sul (SEPRORGS), the Association of Rio Grande do Sul to Support Software Development (Softsul) and the Municipality of São Leopoldo.

In May of 1998, the construction of the technological complex began; the plan was to accommodate a technology incubator, a technology institute and a company condominium: UNISINOS was in charge of the executive management of the complex. Just over one year later, the Informatics Pole of São Leopoldo was inaugurated on 30/06/1999.

We can say that the growth phase initiated ten years later, on 13/11/2009, when the technology complex was renamed Tecnosinos – Technology Park of São Leopoldo, accommodating since then the Pole, the Father Rick condominium and the UNITEC incubator.

2. In view of the fact that Tecnosinos started as an IT Pole, and only later assumed technology park functions, we encounter one Mr. Technology Park in the start-up phase and a different Ms. Technology Park in the growth phase.

It was the will of several actors that led to the creation of what constitutes Tecnosinos today. In the start-up phase Claudio Carrara, president of Assespro/RS for the 1997/1998 biennium, was the main promotor of the creation of the Informatics Pole. Siegfried Koelln, Director of the company SKA, led the design phase and the implementation of the Pole, which in turn promoted the creation of Tecnosinos. Sigfried remembers that before launching the Pole, he asked the Executive Power in March 1993 to provide incentives to attract information technology companies to São Leopoldo:

> *"I was in the prefecture and I was received by the deputy mayor Ronaldo Ribas. I spoke about the necessity of launching a competitive city compared to other municipalities, offering tax-exemption status to the Informatics sector … The Pole empowered a new development outlook for São Leopoldo, UNISINOS, and the existing informatics companies, and created optimal conditions for new companies to grow and achieve success … there would be no park without the contribution of technology companies, which generate capital, employment and a variety of new*

products; the project would likewise be unviable without the support of the university's intelligence and research". (ACIS, 2013: 8-9).

The creation of the Informatics Pole demanded the effort and participation of different sectors, the mobilization of entrepreneurs, university students and the government. Siegfried attributes the success to the alliance between ACIS/SL, UNISINOS, and the Prefecture; also to the Informatics sector entities Assespro/RS, Softsul and Seprorgs; the Government of Rio Grande do Sul and entrepreneurs from the informatics area. "This alliance has proven capacity of men to dream, think, plan and execute. We gathered our dreams and structured this fort that nowadays achieves international economic notability," he summarizes (ACIS, 2013: 8).

After 14 years of existence, from 2009 to 2015, Tecnosinos had Susana Kakuta, an economist and sociologist, as director[2]. With her professional profile, she fulfilled the requirements for this position: the combination of knowledge from the university with the entrepreneurial mindset of technology-based companies and public services. The managerial responsibility of the park implies the strategic management of a business cluster whose business volume surpasses 1.3 billion dollars per year (ACIS, 2013: 13).

UNISINOS works vigorously to contribute to the prominence of Rio Grande do Sul on the map of global knowledge economics, gradually centering on technology innovation. For Marcelo Aquino, the current rector of UNISINOS, Tecnosinos proposes an economic model of regional development, motivated by the magnitude of the entrepreneurial initiative and innovation:

"It involves a strong alliance between UNISINOS, the Park companies and the spheres of Public Authority, where the convergence of these agents creates a favorable competitive environment. The park has a variety of high-tech companies, national as well as from nine foreign countries, ranging from North America and Europe to our far Asian associates. This integrates the vision of UNISINOS to be recognized as a global research university. Today we can

[2] PhD in Sociology and International Relations (Complutense University of Madrid, Spain) and MBA in Japanese market (Japan External Trade Organization, JETRO). She was president of the state bank Caixa Stadual S.A., Development Agency (RS/CAIXA) and executive at The Support Service for Micro and Small Enterprises (SEBRAE/RS)

perceive the added value to society through new employment opportunities and quality-of-life improvements," concludes rector Aquino (ACIS, 2013: 23).

In this way, the technology park can contribute to the knowledge development of the region of Porto Alegre-São Leopoldo.

3. Tecnosinos has a clear identity, expressed by the park's name and logo. The identity of the park has to do as much with the symbolic aspects represented by its name and logo, as with its focus areas. The name and logo express a great deal in terms of identity, mentioning that it is a technology park and where it is located (see Figure 1). The name and logo do not show the connection with the main interest areas (five) of the park and the association with UNISINOS. This may be due to the great diversity of key areas, which complicate the design of a logo and a name that can cover all the areas.

====Figure 1 suggested about here =====

According to the data provided by the park administration, in 2009, ten years after the inauguration of the Technology Complex, the *Polo de Informática de São Leopoldo* was renamed Tecnosinos: Technology Park of São Leopoldo. With three already consolidated specialties, Information Technologies (with 25 companies that year), Automation and Engineering (with five companies) and Communication and Digital Convergence (with ten entrepreneurs, six of them designing games), the park announced the establishment of two new specialties: Functional Foods and Nutraceuticals, and Socio-environmental Technologies and Energy.

Nevertheless, the development differences between the different areas are perceptible. Thus the percentage of companies established in the park at the end of 2014 was: Information Technologies (TI) 59%, Automation and Engineering 17%, Communication and Digital Convergence 19%, Functional Food and Nutraceuticals 1%, Socio-environmental Technologies and Energy 3%. Together, these areas are essential to Tecnosinos. The question is if together, these key areas can create the optimal conditions for the park to be successful. Clearly the first three areas were chosen according to the specialties of UNISINOS, ACIS and the Informatics Pole, and complemented with the successful integration of electronics companies that support the economic development of the region and the country. Many

successful science parks concentrate on the area(s) of knowledge in which the university or the region specializes. From this point of view, the selection of the key areas has been a good decision. According to authors such as Prochnik (2010) and Bampi (2009), the great challenges for Latin America in the field of electronics have to do with improving production; incorporating component production, especially semiconductors; increasing production scales; and participating and taking advantage of the opportunities generated by existing or emergent Global Value Chains. Due to its importance for the development of electronic chains, component production for semiconductors is considered the "great challenge for Brazilian industrial policy" (Bampi, 2009: 21).

One important aspect of science park identity is the cognitive distance between its key areas. Nooteboom et al (2007) explain the importance of a certain approach with the term cognitive distance. An optimal cognitive distance is one in which the knowledge and experience that the actors have is similar enough to allow them to understand one another, but different enough to allow them to learn from each other as well. If we consider this, it is clear that a science park has to choose wisely which knowledge areas it intends to cover. At the same time, the region can develop its leadership position in these areas, because the objective of a park associated with a university is the creation of more and new knowledge in these niches. In the case of Tecnosinos, these areas can be divided into two groups of different cognitive distance: in the first group, Information Technologies (IT), Automation and Engineering, and Communication and Digital Convergence; in the second group, Functional Foods and Nutraceuticals, together with Socio-environmental Technologies and Energy. The first group is historically more developed, as shown in section 2, in the university as well as in the park, and has a closer cognitive distance with enough connections for the people who work in these areas to learn from each other and even develop projects together. With regard to the second group, besides having a limited presence in the park, they have their differences and a bigger cognitive distance, which poses a development challenge for the university as well as the park and the pertinent institutions. Furthermore, Tecnosinos is accommodating a mixture of start-ups (Freire, 2011) and university spin-offs (da Luz and Sanchez, 2013) with more mature foreign companies that have ties to university institutes, with their research and development components (de Oliveira and Balestrin, 2015).

The interaction between the start-ups installed at Tecnosinos for open innovation is due mainly to the complementarity that the park pursues: "…it is a rather common situation that a company from Tecnosinos, to satisfy a particular demand, outsources to two or three companies from the park," exemplifies the park director (BIA, 2010). Regarding the interaction between the university and the industry, the park director comments that "UNISINOS prepares professionals from all the specialties of the park and we are continuously creating mechanisms to assure greater student participation in the companies." Also, the university has participated in many projects associated with companies such as SAP, and also offers support from its Technology Transfer Office. Nevertheless, the collaborative research projects of the companies from the park and UNISINOS are emergent, and require developing strategies for an effective collaboration, as in the case of the strategic agreement with HT Micron: in addition to the company committing to invest 4% of its billing in research projects, at least half of this must be allocated for projects with UNISINOS. The initiative aims at the development of a scientific-technological infrastructure for semiconductor encapsulation. However, due to the university's lack of experience in this field, it will face a challenge in developing its capacity to absorb any knowledge related to this technology. The results provided by a study (de Oliveira and Balestrin, 2015) suggest that the absorbing capacity of UNISINOS can be improved through actions that influence this knowledge basis, the human resources related to the projects associated with this field, the organizational structure, and the inter-organizational relations that can improve this information. It was also found that the starting stages of the project, which involved ready-to-use technology, required timely actions, which gave the university quick access to external knowledge. Subsequent stages, which include the development of new knowledge, require measures whose results will be generated over time, thus allowing the university to improve its absorbing capacity and enabling it to provide more elaborated knowledge.

4. Tecnosinos is inserted in a society, Brazil, allowing for the protection of product or process knowledge, via patents, secrets or any other means in The National Institute of Industrial Property (INPI). Regarding intellectual property and technology transfer aspects, the Innovation and Technology Transfer Center (NITT) of UNISINOS has the mission of orientating and supporting the technology innovation actions, assisting researchers and actors

from the university as well as from the enterprises of Tecnosinos in the submission and registration of intellectual property and technology. In the middle of 2014, UNISINOS established its Intellectual Property and Technology Transfer Policy in the Rector's Resolution No. 08/2014, as amended and ratified by Resolution No. 16/2014, which aims to establish the criteria for the management, protection and promotion of intellectual property creations resulting from the research activities carried out in the different units of the institution. This has been true since the foundation of NITT (year) and their associated ITT.

This is an area that will require special actions from the university to invigorate its technology-based entrepreneurship.

Reactors: Those actors involved in the location, preparation, building, management and expansion of the STP.

5. Tecnosinos also has in UNISINOS a source of management support with established or recognized expertise in financial and other business development matters. The operational management is carried out by UNISINOS staff and is incorporated as a cost center in that institution, having to meet pre-established institutional goals. Tecnosinos has its basic infrastructure already implemented as well as a mature real estate strategy with the lease of buildings and rooms, land for sale and with partnership for investment in new buildings to be made available by Tecnosinos. In addition, their work is sustained by long-term development plans, which are called the Tecnosinos Road Map into the future.

The governance of the park is entrusted to the representatives of the triple helix. The governance has two levels, one of a strategic nature and the other of an operational-managerial-organizational nature. The first one has three votes: one belongs to the university (rector or alternate, usually a director), another to the Prefecture of São Leopoldo (mayor or alternate, usually a secretary) and a shared vote for two business associations: ACIS/SL and a representative of the companies in the park. This council meets twice a year to deal with long-term strategic planning matters (Guedes, 2013; Kakuta, 2012).

Tecnosinos has an executive director with a focus on external relations but that also has internal control through the coordinator of the UNITEC incubator. Four managers report to the coordinator. Each has a distinct responsibility: i) technology, marketing and external

relations; ii) training (creation of competencies in the companies and funding searches); iii) project management, especially park development projects focused on government calls for tenders; and iv) legal and administrative relations with companies and coordination of the Talents program. Among the assignments carried out by the management team are generating, updating and executing the business plan according to the main stages of development (the current ones are presented on Table 2).

===== Table 2: About here==========

The growth of Tecnosinos was financed mainly with public funding from a variety of federal and local sources in the first development stages of the science park; a task that is pending is to evaluate the economic sustainability of its long-term operations to determine whether it will require constant governmental support.

6. Tecnosinos as a whole has the capability to select or reject which firms will enter the park as long as their business plans are coherent with the science park identity (see section 3.3.). The applicants must present a business incubation plan. Once accepted, it is evaluated on a monthly basis and receives the managerial support through an association with The Support Service for Micro and Small Enterprises (SEBRAE-RS).

In the physical area of Tecnosinos the companies coexist in different development stages: maturity, recently graduated from the incubator and in incubation. The park has several options to accommodate them. At the beginning of 2014, the incubator supported 34 projects, with adequate installations for rising innovation and technology-based companies included in the park specialties.

To meet the space demand of the start-ups and the consolidated companies that come to the park, there are two locations: The Father Rick building, consisting of five floors, is managed by an outside company on behalf of the university; and the Partec Condominium, consisting of seven floors, is managed independently from the park. This building houses mature companies like HCL from India.

While some companies construct their own buildings on the park area, others have signed lease agreements. A special case is HT Micron, a joint company between Hana Micron

(South Korea) and a group of Brazilian associates, which announced investments for US $200 million during the next five years for a semiconductor plant that was constructed by UNISINOS in the park. Another example is the ecological SAP building, built to United States Energy Leadership and Environmental Design (LEED) standards. Among the criteria considered for the selection and location of the development center, the president of SAP Labs highlights "the talent availability, global competitive costs (even in comparison with China and India), the ability to grow, the fact of being inside a university campus, the presence of some associates of the park as well as the beauty of the surroundings" (BIA, 2010).

The attraction policy of Tecnosinos is based mainly on:

- The good maintenance of the brand. Many companies are interested in it. This also refers to the dissemination of achievements in different media (magazines, newspapers, radio interviews and TV, as well as social media on the internet).
- "Anchor" companies that need providers and/or provide products for a particular sector; textile companies that require R+D associated with the university; Nestlé for example, which has research projects with ITT Nutrifor.
- Outdoor fairs and events, with companies and/or prospecting missions. They participate in the APEX Governmental Investment Attraction Agency, where they compete for bids to attract companies interested in entering the Brazilian market. Nowadays it focuses on attracting photovoltaic and nutraceutical companies.
- New university spin-offs through the ROSER Award with the coordination and participation of UNISINOS' Curricular Axis of Entrepreneurship and Innovation, which supplements the university's different curricular programs.
- Regarding the criteria for a company's admission to the park, the requirements are:
    - Belonging to one of the park's strategic fields.
    - Doing part of their R+D in the part.
    - Having a clean process (GreenTech Park)[3].

[3] The objective of Tecnosinos as a Green Tech Park is to establish a set of environmental goals to be met by companies located in the park. The program aims to identify, characterize and evaluate the environmental impacts, approaching businesses in an environmental context. Companies in the park can exchange experiences and gather in search of partnerships that improve their working environment and solve problems, adopting practices that will contribute to Tecnosinos becoming a green park, bringing benefits to the environment and efficiency to companies' production processes, in contrast to an eco-industrial park (EIP), which is defined as

- Agreeing to work together, or being willing to collaborate with other companies from the park.
- A business plan (requirement for start-ups and spin-offs), which will be evaluated by an *ad hoc* committee.
- For the consolidated companies: an employment impact and billing report.

It was also found that the collaboration work mentioned in the fourth bullet of these criteria was considered by the incubated companies to be one of the features that offered the greatest benefits, in competitive terms, when they were incubated in the park (Freire, 2011; de Oliveira, 2010).

When tenants were asked what they valued in the park, one incubated company highlighted the environmental cooperation between companies, the ability to always stay on top of the incentive laws, government calls for tenders, training and other events that contribute to the company's growth. Another determinant factor for being installed in the park is "the technological environment that keeps the company from becoming isolated in a commercial building and allows it to be inserted into an environment where the air we breathe is technology, a factor that contributes to staying up-to-date technologically …. [and] being inserted in a reputable Park such as Tecnosinos generates credibility with customers and suppliers." Nevertheless, it was detected that there are still gaps in some solutions offered by park, like the delay or inaccessibility of services at certain times or the lack of ability of some of the professionals who provide support to incubated companies. It also appears that "services are not run exactly the way they were promised at the time that we entered the incubation process" (an incubated company).

7. Tecnosinos has access to some qualified research and development personnel in the areas of knowledge in which the park has its identity. UNISINOS' Innovation and

''a community of manufacturing and service businesses located together on a common property. Member businesses seek enhanced environmental, economic, and social performance through collaboration in managing environmental and resource issues… The goal of an EIP is to improve the economic performance of the participating companies while minimizing their environmental impacts. Components of this approach include green design of park infrastructure and plants (new or retrofitted); cleaner production, pollution prevention; energy efficiency; and intercompany partnering. An EIP also seeks benefits for neighboring communities to assure that the net impact of its development is positive'' [Lowe, 2001: section 1.2].

Technology Transfer Center (Nitt) is responsible for articulating research, development and innovation (RDI) services and solutions for companies and organizations through the technological institutes (ITTs), research laboratories, research groups and researchers, promoting technological development and innovation in the university and its partners. Nevertheless, the ITTs' reach and experience are limited insofar as the institutes were created just a few years ago and it is unrealistic to expect them to constitute a sound source of scientific results to be used by industry in such a short period of time.

A technology park is based on intensive knowledge activities and, as a result, depends greatly on the availability of qualified human capital. Regarding the relations between Tecnosinos and UNISINOS, they can be observed in three out of the five technology institutes (ITTs)[4], as shown in Table 3. Through these institutes, allied companies are provided with the necessary structures to carry out research according to their needs.

===== Table 3. About here =====

The technology institutes are among the university's main representative actors for carrying out projects in alliance with companies; the areas that they cover become the main interest of these projects. Also, it is emphasized that the creation, planning and structuring of those technology institutes occurred through a process in which researchers from the different strategic areas participated directly, along with a specialist in the elaboration of business plans and the Academic Research and Post-Graduate Unit of UNISINOS (UAPPG). Each institute is linked to a Professional Master course at UNISINOS. That is why ITTs are considered supporters of the institute's strategy regarding research, development and innovation service for companies.

Executors are those who manage the STP's output, which could be the commercialization of high-technology goods and services, technology transfer, knowledge spillover, spin-offs and innovations. This category of actors is supposed to manage the park

[4] Two of them do not act inside the main focus areas of the park: ITT Performance and ITT Fóssil. The latter, however, has significant research activity in coordination with Petrobras.

profitably and create wealth for both the immediate local community and ultimately for the national economy in the global market

8. Tecnosinos has the capability to provide marketing expertise and managerial skills to firms, particularly SMEs lacking such a resource. This is done through various University and Government programs, including training and mentorship programs. Tecnosinos has advanced since the early years due mainly to its internationalization project. For this to occur, it had adopted two strategies. The first one has to do with attracting foreign direct investment (FDI) from leading companies in the TIC sectors and/or related to SofteK, SAP, HLC etc. The actions undertaken for that purpose have been meetings and governmental missions to Korea and Germany, and participation in calls for tenders made by the Brazilian Trade and Investment Promotion Agency (Apex-Brasil) for the assimilation of FDI in the park. For the second strategy, companies from the park attend fairs such as CEBIT in Germany (www.cebit.de) and GITEX in Dubai (www.gitex.com), and visit Silicon Valley in California. All these actions have the support of the government at all three levels, and in the case of Germany and Dubai, there is a Brazilian adviser who resides in Germany and works as the liaison between Brazilian companies and possible European or Arab companies or investors.

Like most modern science parks, Tecnosinos accommodates an incubator, called UNITEC, in addition to providing the space for rent with attractive conditions for the incubator's facilities. Its mission is "to create the necessary environment for the emergence, growth and generation of added value through the establishment of technology-based companies that impact Brazil's economic development and the region's socio-environmental sector." UNITEC is the business unit of UNISINOS and the representative for the executive management of Tecnosinos. UNITEC is responsible for encouraging and promoting the integration of incubated and consolidated companies in the park with the university, building and achieving the goal of technological innovation, fortifying the generated knowledge in the university, and forming strategic internal or external alliances for the emergence and strengthening of entrepreneurship based on innovation and sustainable development. These are the responsibilities of UNITEC:

- To stimulate innovative entrepreneurship;

- To promote university-business integration through applied research;
- To support the creation of competencies for innovation;
- To act on the attraction and consolidation of investments;
- To act on the management and training of resources;
- To act on the construction of the institutional image of Tecnosinos; and
- The executive management of the park.

The UNITEC Technology Complex is a strategic planning project from UNISINOS, and has earned greater importance lately due to the University's decision to improve the harmony of its technological competency components and also of the companies installed in the park as a way of focusing investments, fortifying its focus on technology and obtaining results for local and regional development.

The NITT seeks to be recognized as a reference in technology transfer from the University to the productive sector. Among the services provided are assistance in the preparation and development of RDI projects, university/business cooperation, tax incentives, organ development and venture capital, technological partnerships, open innovation, advice on intellectual property (deposit, registration, licensing), and assistance in structuring innovation management models in organizations. It also provides technological solutions for companies (lab tests, applied research, analysis, prototyping, consultants and technology capabilities), and opportunities for RDI where organizations and individual inventors can carry out innovation projects in partnership with Nitt/ITT.

9. Tecnosinos does not have consultancy firms in the park, or technical service firms, including quality control firms. The managerial consultancy services are external; the Tecnosinos managerial team only directs or recommends the requests it receives to its experts in the corresponding areas, who may be consultants and/or academics with or without ties to the university. Tenants do have access to the services offered to the academic community of UNISINOS: bank, post office, library, etc. Moreover, it is important to mention the easy access to different educational services in both a narrow and broad sense (continuing education). Nevertheless, the managerial consultancy services are external and depend on governmental support.

10. Tecnosinos companies are able to market their high-valued products and services. One of the main obstacles for accessing the different markets is language. The globalization process in Brazil and the internationalization of its economy has accelerated greatly. Even though it has quite a large internal market, in order to maintain its growth, employment, technology innovation levels, etc., Brazil requires an active international economic interaction in which a knowledge of English, Spanish, German and Korean are within the possibilities offered by the language school of the university, Unilinguas.

An interesting way of accessing global markets is by the spill-over of subsidiaries of multinational companies through direct foreign investment (CEPAL, 2011). In the case of Tecnosinos, subsidiaries of global companies were installed as SAP, HLC, and especially, HT-Micron.

A special case has been a strategic alliance that gave rise to HT-Micron, a Brazilian company founded in 2009 through a joint venture between Hana Micron (South Korea) and Parit Holdings Group (Brazil). The objective of HT-Micron is to provide local solutions for testing and packaging semiconductors. With its new 10,000 square-meter headquarters, HT is one of the leading semiconductor factories in Latin America. Its production capacity will increase and it will be capable of manufacturing with the most advanced technologies in the world, such as Stacking, Hybrid, SIP/3D and others. Nowadays the HT-Micron project in Tecnosinos has 85 employees.

The park has easy connections with the Salgado Filho International Airport and the metropolitan area of Porto Alegre by way of the BR 116 freeway and the Suburban Train.

Additionally, the current rector of UNISINOS, Marcelo Aquino, is also the president of the *Airport 20 de Setembro* committee, expected to be constructed near the metropolitan area. Once the project begins, the airport must be used; he noted, "I think that with the new airport the South Pole route can be explored. Normally when I travel to Asia, I am forced to travel to Europe or United States. The new airport could innovate with a new more direct route to Asia by way of the South Pole. Brazil has to qualify as an entrepreneurial nation. We have to make an international trajectory for our scientists, entrepreneurs and politicians. The human difficulties are global and the solutions are complex. So we must leave Brazil; we have to take a leap with our economy."

Concluding remarks

Tecnosinos directly meets most of the prioritized criteria of the Cabral Dahab Science Park Paradigm and shows how different actors have contributed to its award-winning and sustainable growth. It demonstrates that for practical purposes and in particular as an evaluation tool, the prioritized paradigm and the three-determinant trajectory (government, knowledge center and private sector) show how the three stakeholders are coming together to establish a sustainable technology park. This trajectory recognizes the distinctiveness of each stakeholder but requires that the working relationship be coordinated among them and appear in the governance of the park as unified. In a way, the three-determinant trajectory is basically similar to the "triple helix" model, which emphasizes the triadic relationships among the institutional spheres (i.e. university-industry-government); but it transcends the "triple helix" model in that, beyond the simplistic triadic basis, it actively involves other distinct stakeholders such as NGOs and international actors who do not necessarily belong to the triad.

Point two identified the identity of two individuals whom we called Mr. Technology Park in the start-up phase and Ms. Technology Park in the growth phase; they were very visible – but further studies are required to analyse their professional profile and leadership.

Several points of the Tecnosinos case call for discussion. By looking at the following points with more care, the management of Tecnosinos may increase its probabilities of success with the support of UNISINOS:

Point three, regarding the identity of the park, shows that a cluster of innovation can emerge naturally by a combination of factors such as demand and supply of regional resources, or artificially generated through public policies of the local government. Silicon Valley is an example of the former while the Hsinchu Science Park in Taiwan and Kista park in Sweden were created by their respective governments. The evidence found in this research case study identifies Tecnosinos as a park that emerged from the supply and demand of IT resources in the region but in addition, the government supported the creation of two new areas (Functional Foods and Nutraceuticals, and Socio-environmental Technologies and

Energy) both in the park and at the university with the intention of generating new areas of regional development.

Points six and seven, which deal with the attraction and/or generation of companies to become residents of the park, show that there is a disproportionate balance in the types of businesses installed in the five focused areas of the park. There is also almost no university patenting and, consequently, scant transfer of technology from the university to companies and a low generation of university spin-offs in these areas. Although UNISINOS declared its intention to become a research university, it is far from it, at least in the focus areas of the park; the establishment of doctoral programs will be required in these areas and the subsequent production of innovative product or process technologies, with the associated industrial property, that can be transferred to companies. On this basis, the park will generate a virtuous circle for cluster development of companies in these areas as predicted by the triple helix theory.

Point nine refers to the incubation practices at Tecnosinos. Even though the park is working toward the CERNE certification, it has been delayed and the work is still at level two. We suggest the park authorities review good practices and lessons learned from incubators in some developing countries (Kirk and Catts, 2004; Lalkaka, 2003; Lalkaka, 2002).

As can be seen from the Tecnosinos case, the prioritized criteria of the Cabral Dahab Science Park Management Paradigm are a very useful tool for managers, evaluators and funding agencies/companies in underdeveloped countries.

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Table 1. The refined and prioritized Cabral–Dahab Science Park Management Paradigm

A Science/Technology Park should:

1. Have the backing of powerful, dynamic and stable economic actors, such as a funding agency, political institution or local university (Determinants).
2. Include in its management an active person (or group of people) of vision, with power of decision and with a high and visible profile, who is (are) perceived by relevant actors in society as embodying the interface between academia and industry, long-term plans and good management – Mr./Ms. Science Park (Determinants).
3. Have a clear identity, quite often expressed symbolically as the park's name choice, its logo or the management discourse (Determinants).
4. Be inserted in a society that allows for the protection of products or process secrets via patents, security or any other means (Determinants).
5. Have a management with established or recognized expertise in financial matters, and that has presented long-term economic development plans (Reactors).
6. Be able to select or reject which firms enter the park. Each firm's business plan is expected to be coherent with the science park identity (Reactors).
7. Have access to qualified research and development personnel in the areas of knowledge in which the park has its identity (Reactors).
8. Have the capability to provide marketing expertise and managerial skills to firms, particularly SMEs, lacking such a resource (Reactors/Executors).
9. Include a prominent percentage of consultancy firms, as well as technical service firms, including laboratories and quality-control firms (Executors).
10. Be able to market its high valued products and services (Executors).

STP	**Determinants**	**Reactors**	**Executors**
Start-up	1, 2, 3, 4	5, 6	
Growth		7, 8	8, 9, 10
Maturity			
Diversification			

Source: Sanni, Egbetokun and Siyanbola, 2010: 67

Table 2: Main stages of the development of Tecnosinos

	Timeline
Implantation of the CERNE* incubation certification process.	2014 – 2015
Construction of the UNITEC II incubator	2014 – 2015
Structuration of the External Incubation Process	2015 – 2019
Expansion of the Talents TECNOSINOS Program	2013 – 2014
Showroom for the incubated companies and the history of the park	2012 – 2014
Implementation of the UNITEC II incubator	2015 – 2019

*The Reference Center for Support for New Enterprises (CERNE) is a platform that aims to promote significant improvement in the results of the incubators of different activity sectors. For this, it determines best practices to be adopted in several key processes that are associated with four levels of maturity.
Source: documentation provided by the manager of UNITEC

Table 3. Technology institutes (ITTs) at UNISINOS that are associated with Tecnosinos

I) List of Associated Labs
1. **ITT-FUSE** Insurance Instrumented Systems reference center – In operation since 2012
2. **ITT-CHIP** Semiconductor reference center – Inaugurated in 2014
3. **ITT-NUTRIFOR** Functional Foods for Health and Nutraceutical Center – Inaugurated in 2012
II) List of Technology services offered by the ITT labs
1. Qualification and functional security assays.
2. Technology solution development.
3. Basic research on technology areas.
4. Joint development of products and innovative processes.
III) Research areas of UNISINOS related to Tecnosinos
1. Information Technologies.
2. Semiconductors, Automation and Engineering.
3. Communication and Digital Convergence
4. Life Science, focused on Functional Foods.
5. Social-environmental Technologies and Energy.

Source: Elaborated by the authors.

Figure 1: Logo of Tecnosinos