Community leadership and the Triple Helix model as determinants of the constitution of science parks

A Brazilian experience

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Abstract

Purpose – The purpose of this paper is to analyze and understand the condition that lead to a constitution's path of Brazilian Science Parks, in the State of Rio Grande do Sul, and consequently to propose a new dimension of analysis to the Triple Helix.
Design/methodology/approach – A qualitative approach was used to elaborate a descriptive and exploratory research design, where a case study method was applied on six science parks.
Findings – The use of the Triple Helix model could not explain the Brazilian Science Park development realities. A new element, related to the innovation model, was considered as a determinant in the constitution of the Brazilian parks, and is represented as the community leadership category, as the Fourth Helix.
Research limitations/implications – Since it is a qualitative study, the results obtained have a strong relation with the local, cultural and historically constructed contexts. Bias from the researchers' subjectivity in the data collection procedures is present, although the validity and reliability measures were performed.
Practical implications – The construction of designed and implemented specific "fertile models," which are capable of developing the necessary conditions for the constitution and the consolidation of science parks in Brazil.
Social implications – Such empirical contribution comes from data referring to spontaneous and endogenous local community development movements.
Originality/value – The identification of a new element of the Triple Helix innovation model is represented as the community leadership category and is considered as a key determinant in the constitution of the Brazilian Science Parks.

Keywords Innovation, Triple Helix, Brazilian Science Parks, Community leadership, Fourth Helix
Paper type Case study

1. Introduction

The metaphor of the Triple Helix innovation model that suggests an interaction between three specific environments: university, business and government has gained popularity in recent decades in the academia and governmental instances. It enriches the conceptual and empirical dimensions of innovation as a systemic phenomenon, seeking to fill the gaps in the innovation systems and to propose alternatives to innovation environments committed to regional development. It is widely used as a reference for designing policies and programs aimed at improving local conditions for supporting innovation (Etzkowitz and Zhou, 2006, 2018).

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A science park is considered as a hybrid organization, which is the result of a systemized form of cooperation between the university, the government and the private sector organizations. It constitutes an important regional development tool, capable of transforming the socio-economic profile of a region. It promotes the culture of innovation and the competitive advantage of companies and institutions, by stimulating the creation and the development of technology-based companies. Science parks are the source of qualified jobs and they provide space for creativity, innovation and learning; by involving students, academics, researchers, entrepreneurs, political actors and the whole society in general (Felsenstein, 1994; Löfsten and Lindelöf, 2003; Caiazza, 2014; Etzkowitz and Zhou, 2017, 2018).

The southern State of Rio Grande do Sul is considered as a unique case. It represents the only Brazilian State that established a network of science parks distributed in different regions. The network includes the development of 15 science parks in different phases of consolidation, over a period of 20 years. The first joint initiative started with the *Porto Alegre Tecnópole* Program in 1994, a joint initiative of the Porto Alegre City Hall and the State Government Tecnópole Program. Today, the effects of such initiative generated approximately 400 companies and around 20,000 jobs. Two of those science parks, Tecnopuc and Tecnosinos, were awarded the prize for "best Science Park in Brazil" by the *Associação Nacional de Entidades Promotoras de Tecnologias Avançadas* (Anprotec, 2017). According to Audy and Knebel (2015), the State of Rio Grande do Sul stands out as one of the main poles of innovation in Brazil.

The local characteristics and the context of the institutions represent the key determinants of the constitution of science parks. They constitute a broad path of development, based on peculiar local realities, which makes it difficult to systematize and replicate valid models for their constitution (Etzkowitz and Zhou, 2018).

The development and the consolidation processes of science parks, which includes the different actors in the Triple Helix model perspective, have rarely been investigated (Champenois and Etzkowitz, 2018); where in most cases, only the final results were analyzed, while the initial process was ignored (Etzkowitz and Zhou, 2017). Most of the literature on the Triple Helix concept focuses on investigating the university, the industry and the government in a holistic perspective, but it neglects how their institutional identities influence the dynamics of interaction (Etzkowitz and Ranga, 2015). Recently, the concept of "innovation incommensurability" was proposed by Etzkowitz and Zhou (2018) to analyze the gap between science park aspirations and accomplishments. In addition, the research works on the interaction between the university–enterprise–government trilogies mainly converge toward the actors, instead toward the processes that generate such realities in a community (Etzkowitz and Zhou, 2006).

The present paper intends to fill such gap, by analyzing and understanding the path of the science parks' constitution in the State of Rio Grande do Sul, Brazil; and to propose a new dimension of analysis for the Triple Helix model that emerged from the local Brazilian data analysis, called community leadership.

Although the contributions from local leaders are mentioned as important in the origin of innovation environments and ecosystems, they were retaken in recent studies as the regional innovation organizers and initiators (Etzkowitz and Leydesdorff, 1995, 2000; Etzkowitz and Ranga, 2015; Etzkowitz and Zhou, 2017); mainly as the responsible for formulating and implementing responses to any declining productive capacity in a particular region (Etzkowitz, 2018), or as a key individual capable of working in a team (Champenois and Etzkowitz, 2018). In that context, this study seeks to fill out this other gap by doing an in-depth research on the role of leadership as a key element of the synergy among the various actors in a science park constitution project and to facilitate an interactive and collaborative work capacity for innovation.

The adopted leadership approach involves empirical investigations of given phenomena and the understanding of the behavioral and individual concerns of the leader. It explores the elements of the groups and communities that prioritize shared efforts to produce collective results. In such context, community leadership is understood as a process of social construction, capable of generating complex relationships and interactions between the actors and their different contexts (Uhl-Bien, 2006; Uhl-Bien *et al.*, 2007; Ospina and Foldy, 2010; Uhl-Bien and Arena, 2018, Uhl-Bien and Carsten, 2018). These efforts help to understand and explain why a particular form of leadership emerges in a particular context and that may reveal a new definition and framework of leadership, and the addition of a new helix to the Triple Helix model.

Additional elements to the original Triple Helix model, based on North American regional realities and as proposed by Etzkowitz and Leydesdorff (1995, 2000), demonstrate the need for empirical studies with the objective of exploring innovative environments in developing countries that have unique and different characteristics by nature. Leydesdorff (2012) has recognized that "empirical studies may suggest other Helix to complete any type of explanation" (p. 25). According to Etzkowitz and Zhou (2006), "anyone may transform the normative analytical framework to take greater account of local circumstances, when an expanded concept may be needed to incorporate an absent fundamental dimension to sustain a rigorous explanation" (p. 79). According to Leydesdorff and Etzkowitz (2003), case studies are appropriate and can be used to explore the relevance of the three main dimensions of the Triple Helix model.

In this context, the present paper proposes to add a new dimension of analysis to the Triple Helix model as a theoretical contribution. The contribution refers to community leadership as the Fourth Helix, as a category that emerged from the data in the analysis of the trajectory of the science parks' constitution process. Such dimension has been neglected until then and its importance, role and influence in the process have not been studied before. Furthermore, the experience of science parks in the State of Rio Grande do Sul can be an inspiration for further studies on the development of regional and national Brazilian innovation systems.

2. The Triple Helix model: university, enterprise and government interactions for innovation

The interactions between the universities, the enterprises and the government, as exposed by Etzkowitz and Zhou (2006), are "the key to improving the conditions for innovation in a knowledge-based society" (p. 24). The model is part of an interaction that moves like a Triple Helix, linking the three actors into innovative process actions. The university segment is active on knowledge generation, where it offers support structures for new ventures and it assumes a leadership role in the Triple Helix model. The government segment includes the legal, fiscal and financial incentives for science, technology and innovation activities. The enterprise segment represents the locus of production and wealth generation (Etzkowitz and Leydesdorff, 2000; Etzkowitz and Zhou, 2017).

The actors preserve their characteristics and traditional identities while also playing the role of others. The knowledge and innovation infrastructure is generated in terms of overlapping between the institutional spheres, enhancing the creation and the development of hybrid organizations such as the science parks. The regional and institutional characteristics of the actors involved in a geographical context become the determinant elements of the model (Etzkowitz and Leydesdorff, 2000; Etzkowitz and Zhou, 2017).

There are many critics arguing that the model is too limited and generic concerning the innovation dynamics aspects and the interactive, non-linear process involving the actors. The problem of context diversity and the inclusion of only three institutional spheres to account for the complexity of the innovation process have generated a

number of challenges about the model. It raises and suggests the introduction of new dimensions of analysis (Viale and Campodall'Orto, 2002; Marcovich and Shinn, 2011; Schoonmaker and Carayannis, 2013; Carayannis and Rakhmatullin, 2014; Ivanova, 2014; Carayannis and Campbell, 2018, Carayannis *et al.*, 2018).

According to Ivanova (2014), one of the first proposed "Fourth Helix" studies was carried out by Baber (2001), exploring the dynamics of relations between the state, the enterprises and the universities in Singapore, and the impact of globalization and the emergence of the transdisciplinary scientific fields. The Fourth Helix referred to the external scientific experts who advised the government of Singapore on science and technology policies.

The debate over the inclusion of other dimensions in the Triple Helix model gained greater repercussion from the Fourth Triple Helix Conference held in Copenhagen in 2002. From the addition of several categories, it was suggested to include concepts such as work, venture capital, civil society and the informal business sector (Etzkowitz and Zhou, 2006).

Since then, several studies have been carried out, suggesting the addition of new helices to the model to better represent the investigated contexts and phenomena. A study by Viale and Campodall'Orto (2002), in the USA and Europe, mentioned that the establishment of defined legal structures and market recognition generate better scientific and technological results than the intervention of government agencies. A study by Kostiainen and Sotarauta (2003), conducted in Finland, identified the concept of "consumer participation" as a key dimension in a new products and services development process. In their creative knowledge environment approach, Hemlin *et al.* (2004) complemented the model by adding the element of creativity, justifying that the characteristics that stimulate the production of knowledge remain neutral in the Triple Helix model. Furthermore, a study involving creative industries in Australia, Colapinto and Porlezza (2012) identified the financial organizations as a major driver of the local innovation system, presented as the Fourth Helix. Finally, the investigation on the links between supply chain management and industrial clustering in China, as brought up by Ikram *et al.* (2018), identify the local community as an extension of the Triple Helix model.

A growing concern about the environment and the opportunities to stimulate innovation and to increase industrial efficiency encouraged the discussion on sustainability as a Fourth Helix alternative (Carayannis and Rakhmatullin, 2014). The authors (Gouvea *et al.*, 2013) introduced a discussion on sustainable resources in the Triple Helix model, arguing that the green economy will shape the global economy in the coming decades.

The study by Carayannis and Campbell (2018) suggests the extension of the Triple Helix model to focus on the knowledge economy. Such Fourth Helix would explain the impact of the knowledge society and the knowledge democracy on the system, and a Fifth Helix could refer to the socio-ecological transactions and the natural environments. According to Carayannis *et al.* (2018), the society is the key player in the innovation processes, considered as the end-user of innovation, which influences the generation of knowledge demand and new technologies. Then, a Fifth Helix could be formed from the interaction and the knowledge exchange of the following subsystems: education (human capital); (economic capital); political (political and legal capital); civil society (social capital and information).

Although it is possible to add complementary helices to the Triple Helix model, Leydesdorff (2012) suggests caution and alertness, since new dimensions require a base of relevancy, sufficient and significant data to make it measurable. The author mentions that the Triple Helix model encourages new research works to reflect on additional dimensions and that any proposition could enrich the semantics of the three initial dimensions of knowledge and innovation.

2.1 Science parks: interactive environments for innovation

Its origin comes from the Californian Stanford University initiative in the middle of the nineteenth century. At the time, the university encouraged its students to incentivize

entrepreneurship in the region with the objective of creating new economic alternatives, by transcending local vocations and investing in new areas of knowledge, such as engineering and exact sciences (Etzkowitz and Zhou, 2018).

The Triple Helix model was also implemented at Stanford University and is recognized as a platform for the creation of new institutions and organizational systems. Such North American environment, considered appropriate to cooperation between university, business and government, may develop the necessary technology for the implementation of new processes and products development. The universities offer technology by conducting research that contributes to the advancement of society. The governments would assume a role of facilitator for the establishment of public–private partnerships for research and innovation (Etzkowitz and Zhou, 2017).

In such Triple Helix perspective, science parks play an important role on innovation and industrial renewal, by assisting technology-based companies in developing new products and by accelerating the diffusion of technology and improving their competitive position in the marketplace (Löfsten and Lindelöf, 2003). Their main goal is to assist the development and the growth of technology-based companies, to facilitate knowledge transfer between universities and companies, to stimulate the development of innovative products and processes and to act as a catalyst for regional economic development (Felsenstein, 1994).

However, science parks are recognized as an important tool to stimulate the formation of new companies in less developed regions, since they offer the appropriate physical infrastructure for regional economic development. The presence of a science park can stimulate the creation of jobs, attract talented labor and investments to the region. New companies may have access to a variety of suppliers, technical expertise and potential partners located nearby (Löfsten and Lindelöf, 2003).

Etzkowitz and Zhou (2018) identified three types of science park development patterns. First, a top-down and bottom-up process, which can either be started from the university toward the industry environments, by hosting spin-offs that receive further infusions of innovation and give back in form of research and training opportunities; or be realized from the industry toward the university environments, with sub-units of established firms located by the university, primarily to host student projects relevant to the firm and to access faculty for consulting. Second, it can be implemented from forward or reversed linear processes, which can be started from the government toward the university environments, where the government takes the lead in building the science park, even without any university involved at the beginning of the project. Finally, it can be created and started from a university toward the government environments, by an entrepreneurial academic who gains support from fellow scholars, the local government, innovation agencies and firms. Finally, it can be created through interactive, non-linear modes, to establish and develop science parks or their virtual equivalents. It may be from any interaction among university, industry and government, or all together, though it could be initiated by one of the actors.

The creation and the implementation processes of a science park and innovation ecosystems are not a simple task since the actions of its actors, the governments, the local universities or companies are not enough to create such a complex initiative if they are isolated. Since their core mission is to generate an innovative approach and a systemic and interactive phenomenon, the confluence of social, political, institutional and cultural factors of a given territory becomes necessary. Its implementation requires the different actors commitment and a long-term vision (Löfsten and Lindelöf, 2003; Carayannis *et al.*, 2018).

2.2 Leadership in a context of innovation cooperation: the relational approach

Leadership has been considered a determining factor for the ability to generate innovation. Consequently, the need for innovation in the organizations has established a new focus for

the leader's role in diffusing his creative endeavors to his followers (Howell and Avolio, 1993). Leadership studies have been conducted in order to identify and analyze the relationship between leadership and innovation, especially about the leader's impact on organizational performance, innovation capacity and creativity, both at the individual and organizational levels (Mumford and Licuanan, 2004, Osborn and Marion, 2009).

Recent studies have demonstrated the challenges faced by leaders to empower and position deciders and their organizations on the problematic of adaptability in complex environments (Uhl-Bien and Arena, 2018); representing alternative leadership approaches that involve relational dynamics and interactive processes, whereby the leadership process is created and built socially (Uhl-Bien and Carsten, 2018). Such approach can be considered as an alternative to study leadership in complex systems, whose focus is no longer exclusively the leader itself. The complexity that influences a knowledge-driven economy requires a different paradigm for leadership, which fits into a complex dynamic and interactive model, based on learning-oriented elements, innovation and adaptability (Uhl-Bien *et al.*, 2007; Uhl-Bien and Arena, 2018, Uhl-Bien and Carsten, 2018).

The relational leadership approach differs from other traditional approaches on leadership since it engenders some kind of social relationship influence and it contributes to the emergence of a social order that provokes change. In an emerging coordination, some leaders are able to influence others in adopting new values, attitudes and goals. The concept of relational leadership is therefore understood as a mobilized influence for the promotion of change within a context of internal and external relationships (Uhl-Bien, 2006).

Day and Harrison (2007) define the concept of relational leadership as a shared ownership of a social system, which presupposes interdependencies between individuals, teams, organizations and the society. It represents a phenomenon that belongs to the sphere of collectively, involving the creation of a system of shared meanings, which constitutes a basis for actions.

The focus of such concept relies on complex dynamics and interactions, underlying the phenomenon of leadership in different contexts. Relational leadership emphasizes on relationships, through which leadership is built, activated, exercised and reconfigured (Uhl-Bien, 2006).

3. Method

In view to achieve a more realistic research perspective, with the objective to establish a new dimension of analysis to the Triple Helix model, the research process was designed to construct a theory, by using Stake's (1978) and Eisenhardt's (1989) cases study theories, which refers to: get started; select cases; create instruments; enter the field; analyze data; shape hypotheses; enfold the literature and; reach closure. The research strategy relies both on a non-linear process of research and theory-building, not intended to disregard a consolidated theory such as the Triple Helix model, but to present a substantive theory that helps to understand and explain a social phenomenon, from the reconstructions of the research subjects' experience (Strauss and Corbin, 1998).

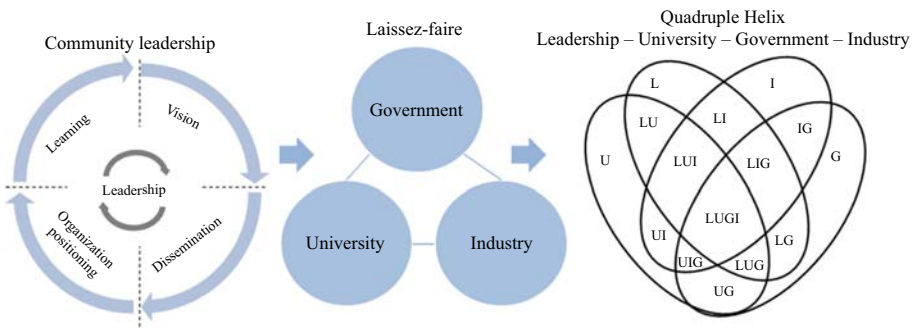
The object of the study includes science parks located in the state of Rio Grande do Sul, Brazil, since the State is considered as one of the main poles of innovation in Brazil (Audy and Knebel, 2015). This "cluster of science parks" has achieved the highest rate of cooperation for innovation projects in the country, the highest rate of product or process innovation and it generates the second largest number in the country's patent applications (IBGE, 2016). Over a period of 20 years (1994–2014), the cluster had the fourth best national GDP results (Brasil, 2014) with a network of parks located in different regions of the State. Two of them, Tecnopuc and Tecnosinos, have won the Anprotec prize for best science park in Brazil (Anprotec, 2017).

The state of Rio Grande do Sul counts 15 science parks, accredited by the State Program of Science Parks, from which the six most important were investigated, based on data from their physical, administrative and operational structures. The evidence was collected at the São Leopoldo Technological Park (Tecnosinos), the PUCRS Scientific and Technological Park (Tecnopuc), the Feevale Techpark, the UPF Scientific and Technological Park (UPF Parque), the Univates Science and Technology Park (Tecnovates) and the Regional Technological Science Park (TecnoUnisc) through participative observations, field diary consultation, document analysis and interviews. The data collection instruments were prepared with the help of three experts with recognized professional and academic experience in science parks. They contributed to the entire process of data collection and analysis, which led to a pilot test (Bencke *et al.*, 2018) to validate the instruments. The choice of the interviewees initiated with subjects who had participated in the constitution and management processes of science parks. The selection of new interviewees occurred by the indication of the ones already involved in the research process up to a total of 25 interviews of all the areas of activities. After each interview, data were tabulated and a data analysis overlap was performed. A preliminary "codes and categories" proposition was proposed with the use of the software Nvivo. By collecting all the sources of evidence for each specific case, the results were presented and discussed among the researchers, who gave guidelines related to data collection and analysis for the next case. Furthermore, the theoretical construct was then presented to one interviewee from each science park to verify if each category and sub-category reflected what was said in the interviews (Eisenhardt, 1989).

An essential feature of theory construction is the comparison between the emerging concepts and theories with the literature, which helps build internal validity and improve construct's definition (Eisenhardt, 1989). The cases analysis made possible to identify the role played by each actor from the university, government and company environments, as proposed by the Triple Helix model. The analytical category "community leadership," which emerged from the analysis of the data of the cases investigated, reached its theoretical saturation when it was possible to abstract data capable of understanding, explaining and proposing a new dimension of analysis and theoretical framework to the Triple Helix model, as shown in Figure 1. It was then possible to understand the limits of generalization of a complex context, which allowed exposing a theory based on community leadership.

4. Characterization of the science parks

Science parks are built in different ways and are adapted to suit different realities. Characteristics of the local context and institutions involved become determinant in the creation of those environments (Etzkowitz and Zhou, 2018).



Source: Elaborated by the authors

Figure 1.
Community leadership and the quadruple helix model

The first initiative to occur in the metropolitan Porto Alegre, the capital of the State of Rio Grande do Sul, was initiated by the Tecnosinos in 1998 with a "software cluster" initiative located on the Unisinos Campus, in the municipality of São Leopoldo. The Unisinos University, the municipality of São Leopoldo, the State public authorities and some leading entrepreneurs jointly supported the project. The main determinants of the initiative were to seek alternatives for the insertion of new economic matrices in the region and to counter its main economic activity in crisis, mainly based on the leather-footwear sector. The study shows evidence of a strong interaction between the university, the governments and the enterprises; from a learning process based on trust and cooperation, in which the actors have assuming different activities and attributions. The Tecnosinos system operates in two complementary systems: strategic and executive governances.

Inaugurated in 2003 and located on the PUCRS University Campus, in the city of Porto Alegre, Tecnopuc did not arise from a pre-conceived project to be implemented, but by seizing opportunities based on a doing-by-learning strategy. The science park's leadership designed a model inspired both by the companies' demand and the university's own capacity to create mechanisms to respond to them, characterized as an intense relationship through research and development projects. The university managed the constitution process and governance of the science park. The Tecnopuc case stands out primarily by its installed research capacity, its collaboration with the PUCRS's MSc and PhD programs and the generation of applied research from experienced academic doctors. It is extended its available physical space for the installation of "tech companies," where the optimization of the area for science has pioneered entrepreneurship as a new mission for the university and the development of new resources and competences, capable of creating an ecosystem of innovation in the University Campus.

The Feevale Techpark, inaugurated in 2005, is the results of the Municipalities' initiatives of Novo Hamburgo and of Campo Bom. Besides the support of both municipalities, the project was realized in association with the business associations of both cities and some representatives of University Feevale. To respond to the economic crisis of the footwear industry and in search for new alternatives toward the diversification of the production matrix of the metropolitan area of Vale do Rio do Sinos, the initiative led to a decentralized model of development with the objective of creating technological units in both municipalities. The model prioritized the attraction of companies in the region, seeking to foster local entrepreneurship. It managed to attract important companies in its Campo Bom unit, although it encountered difficulties in establishing a more effective process of research and development with the participating companies.

Inaugurated in 2013, the UPF science park is located on the University of Passo Fundo Campus, in the municipality of Passo Fundo. It is considered as the first science park in operation outside the metropolitan region of Porto Alegre.

Inaugurated in 2014, the Tecnovates science park is located on the Univates University Campus, in the municipality of Lajeado. It has adopted a differentiated attraction company strategy in his approach with the community, by building a modern and audacious infrastructure to generate and to host new ventures, equipped with a unique research and development structure from the university and business interaction activities.

Inaugurated in 2014, Tecnounisc is located on the Santa Cruz do Sul University campus in the city of Santa Cruz do Sul. It has an integrated infrastructure with the University Campus, a key strategy used to promote greater interaction with students, teachers and researchers, undergraduate and postgraduate courses in the areas where the science park operates.

UPF Parque, Tecnovates and Tecnounisc are the most recent science parks in the State and they demonstrate similar elements responsible for their origin. The first one is the State Government's outstanding role, between 2011 and 2014, through the Department of Science and Technology and Innovation, which highlighted the inducement and the

creation of innovation environments within the state, through its State Innovation Law of 2009, the "Gaúcho" Program of Science Parks and the RS Technopole Program. These universities present themselves as the key actors of their project, by having created their science park in compliance with the guidelines of the State programs and by having used them as a benchmark strategy through the current consolidated models in the State of RS. The business technology industry, in turn, proved to be the least prominent actor and is almost absent in the science park constitution process, which reflects in the difficulty of these parks to attract key enterprises.

4.1 Categories of analysis

The categories of analysis were elaborated from the sources of evidence, through interviews, documents and field notes, which were transcribed into a text form.

The facts about the science parks were initially collected, and then analyzed and explored in search of similarities and differences, and were regrouped in the form of categories and sub-categories. The use of the Nvivo software contributed to organize all the data. The outcome of the data treatment led to the construction of a theoretical scheme, represented by the main and sub-categories. The categories were validated with one interviewee from each science park, through a triangulation process between the researchers and with the participants from the six investigated science parks. The overlapping of the data analysis process with the data collection in an adaptive perspective led the conduction of the research to the generation of the main categories of analysis, as suggested by Eisenhardt (1989) and as presented in Table I.

Table I shows the total number of code occurrences that gave rise to the proposed categories: community led university, governments' role, companies' role and community leadership.

4.1.1 Community led university. The results show evidence that those science parks are primarily the consequence of the universities' management leadership. They managed the projects and the site is generally located in their campuses. They constitute a prominent actor in the constitution of the science parks.

The science parks encountered with the community led universities of Rio Grande do Sul, a fertile ground to develop the necessary conditions for the constitution and the consolidation of their environments. The universities' management leadership generated organizational contexts that allow the construction of a structure favorable to entrepreneurship, innovation and the interaction among multiple actors. Such model in the Brazilian academic scenario proposes a structure and a conducive environment that enhance local leadership performance, with shared responsibilities and autonomy to propose new paths of development. At the same time, the community university has in its "DNA" the commitment to regional development and to the communities in which it is embedded. Table II introduces the category "Community led university."

The concept of community comes from the condition of joining people and the organizations together to make viable joint projects (Vannucchi, 2011). The inclusion of the actors of a local community, such as the municipal authorities, the associations, the schools, the churches and other intermediate organizations, represents a key strategy for

Analysis categories	Occurrences	Encoded words
Community led university	105	10.047
Governments' role	94	9.287
Companies' role	85	9.256
Community leadership	111	8.989

Source: Elaborated by the authors with the Nvivo software version 10

Table I. Total of code occurrences by analysis category

Category	Sub-category	Descriptors
Community led university	Various actors interaction alternative model	Non-state public owned
		Community involvement
		Commitment to regional development
		Does not have owner
		Non-profit
		Democratic management
		Autonomy and agility in decisions
	Science parks constitution leading role	University as a key actor
		Park located and managed by the university
		Park as a mechanism of interaction university

Source: Elaborated by the authors with the Nvivo software

Table II.
Community led university

the existence of the community led universities. They develop in a historical and regional context of debates for the construction of formal spaces of education, through a process marked by the initiative of a civil society, which looks for the alternatives for its development. It may also represent the efforts of the communities and the religious groups to build spaces of social ascension, given the absence of the State in offering access to State public education to the population. It is obvious that the community led universities assume a governance role within the State, by creating training alternatives for the young people who were only present in the capital cities until then (Dorion *et al.*, 2018).

These science parks, when they emerged from a community led university model, operate as a private, single, responsible and centralized decision-making system that enables agility to respond to the local society and companies demands, as they generate public resources. The community led university characteristics become key elements for the constitution, the development and the sustainability of such science parks. The community representatives contribute to the strategic planning, the decision making and they teach, research and do extension activities linked to regional development. The commitments assumed by the community led universities enhance the regional vocation of the science parks and their local impact. They develop and provide educational, scientific and technological services to the community, provoking a disruptive change on the nature and the quality of the education services. The participation of the management jointly with the academic community and the representatives of the regional community create a participative and democratic sense to the decision process.

Finally, the scientific, administrative, financial and patrimonial autonomies of each entity provided agility in the decision-making processes and maintained its management focused on questions related to the development of technological, business, academic and scientific activities.

4.1.2 Role played by the government. In the category "role played by the government," two specific moments of the participation of the government in support of the constitution of science parks stood out. The first one refers to the initiative of the Mayor of the City of Porto Alegre in the creation of the *Porto Alegre Tecnópole* Program in 1994; and by the initiative of the Ministry of Science, Innovation and Technological Development in the creation of the *RS Tecnópole* Program in 2011 (Table III).

The metropolitan region of Porto Alegre experienced a de-industrialization process in the 1970s and 1980s and a significant reduction in the share of the State's industrial gross development product, while at the same time suffered from the industrial growth of its neighboring municipalities and from different regions of the State. The process of de-industrialization occurred due to an economic recession, which inhibited investments and led to industrial relocation in smaller industries.

One of the Government led alternatives was to seek to transform the municipality of Porto Alegre into a technological pole. The *Porto Alegre Tecnópole* Program was inspired by the French experience of *technopoles*, known as an urban and regional development model, which sought to promote the technological development of a given region through the interaction of the local actors and their responsibilities. The *Porto Alegre Tecnópole* Program was constituted in 1995 by representatives of all levels of government, local universities, companies and the civil society.

The leadership of the project came from Porto Alegre City Hall, which assumed a role of articulation between the actors. The main objective of the *Porto Alegre Tecnópole* was to establish independent and articulated actions among the actors for local and regional development. Their main objective was to prioritize the provision of an adequate infrastructure for technology-based companies and the approximation between universities and companies, through the elaboration of projects and the implementation of some science parks, more specifically the Tecnopuc, the Tecnosinos and the Feevale Techpark.

The successful experiences of PUCRS (Tecnopuc), Unisinos (Tecnosinos) and Feevale (Feevale Techpark) have made the State of Rio Grande do Sul a national reference in terms of science parks, and have motivated the State government to create public policies to encourage and to support the creation of innovation environments. Successful experiences influenced the constitution of the State's Innovation Law in 2009, the "Gaúcho" Program for Science and Technology Parks (PGTEC) in 2009, and the *RS Tecnópole* Program in 2011, which contributed in a second moment to the creation of the UPF Parque, Tecnovates and Tecnounisc.

The Ministry for Science, Innovation and Technological Development has assumed a role of inductor in the constitution and the consolidation of those science parks, by establishing public policies and guidelines to support and to provide the necessary conditions for such ventures. The guidelines include the conceptual definitions, the management models, the infrastructure, the technical-financial capacity and the appropriate technical feasibility to the enterprises in a regional context.

4.1.3 Role played by the companies. The role played by the companies happens to be specific to each environment. On the one hand, some assume a proactive stance, by inducing the creation and the development of the science park and being responsible for the strategic repositioning of the university, with the objective to respond to the demands of technology and innovation. On the other hand, some university managements are almost absent in the decisions process to implant and support the creation of their science park (Table IV).

The sub-categories "research and development demand through university, government and companies' interactions" and "influence of anchor companies" emerged from the analysis of the Tecnopuc and Tecnosinos science parks. In both these environments, the corporate sphere plays a fundamental role in inducing its emergence and development. Furthermore, the universities' ability meets and responds to the ongoing project demands from all actors, with the objective to create an environment capable of hosting them and encouraging a process of

Category	Sub-category	Descriptors
Role played by the government	The *Porto Alegre Tecnópole* Program	Stimulus to the interaction between university, government and companies Legal, fiscal and financial stimulus Encouraging the creation of innovation environments
	The *RS Tecnópole* Program	Exchange of governments, discontinuation of public policies and strategic actions to the constitution of innovation environments

Source: Elaborated by the authors with the Nvivo software

Table III.
Role played by the government

interaction to promote innovation. The UPF Parque, Tecnovates and Tecnounisc are characterized by a "weak participation of the university management in the constitution of their science park," although they occurred more recently (2013 and 2014).

The PUCRS case is characterized by a "business opportunity Project" coming from a direct negotiation between PUCRS management and Silicon Valley companies. The initial objective was to host the research and development units of Dell and HP computers for the South American region, through the construction of a science park directly linked to PUCRS and aimed at meeting the research and development demands from the companies. Those multinational companies, represented by the sub-category "anchor companies influence," are recognized as anchors companies since their presence attracted the interest of dozens of companies in the area of information technology to participate in Tecnopuc.

The Tecnosinos case is characterized by the involvement of local business leaders from the Commercial, Industrial and Services Association of São Leopoldo (ACIS/SL), and the Federation of Associations of Brazilian Information Technology Companies (ASSESPRO). The initiative came in the late 1990s from an investment in information technology as a new economic and dynamic matrix for the region that was experiencing a crisis in the leather foot wear sector, which impacted in the constitution and the implementation of the *Polo de Informática* of the city of São Leopoldo.

The Feevale Techpark was formed as a non-profit and independent association, involving the participation of multiple local actors from different municipalities. The institutional sphere of business was represented by the Commercial, Industrial and Services Association of the cities of Novo Hamburgo, Campo Bom and Estância Velha, which participated as actors in the creation of the park.

The most recent science parks, UPF Parque, Tecnovates and Tecnounisc, were inaugurated between the years of 2013 and 2014 and still are in the process of attracting companies. All three projects show a lower involvement of the universities in their process, giving rise to the sub-category "little participation in the constitution of the park." The absence of companies also reflects the difficulties encountered in attracting them to the innovation environment. Among the reasons for a low participation of companies is the lack of knowledge on the importance and the role of the park and the absence of research, development and innovation culture as a business practice.

4.1.4 Community leadership. In exploring the constitution path of the consolidated science parks in the State of Rio Grande do Sul, it was possible to identify the role played by the universities, governments and companies, through the Triple Helix model, from which a new category has arisen: the community leadership. The concept of community leadership becomes a determinant in the science parks constitution process. The community led science parks are the results of the integrated actions of different actors with a common goal to foster entrepreneurship and innovation and to contribute to regional development. Local leaders sought to unite their university, government and companies, by using the

Category	Sub-category	Descriptors
Role played by the companies	R&D demand through university, government and companies' interactions	To establish R&D units at the university Fundraising and tax incentives Recruitment of qualified human resources
	Influence of anchor companies	Attraction of other companies To influence the university's strategic repositioning
	Little participation in the science park constitution	Did not understand the role of the science park Does not have R&D&I as a business practice

Source: Elaborated by the authors with the Nvivo software

Table IV.
Role played by the companies

community university environment for discussion and reflection, and to be able to provide the appropriate infrastructure to host such ventures. Table V illustrates the community leadership category, its sub-categories and descriptors.

By exploring the emergence and the development of the community leadership category, the results show an empirical process that begins with an inspiring vision of the future, through people considered as creative and entrepreneurial, and conceived from the French *technopoles* experience. A shared vision attracts the interest of other people from different environments, who feel committed and responsible for the future of their territory. A clear vision, shared and accepted by the community, encourages a re-thinking of the traditional performance of the institutions involved, and more specifically, a re-direction of the university's strategic actions to institutionalize a new vision and mission. Such new paradigm creates the conditions for the development of a climate and an environment, which becomes conducive of entrepreneurship and innovation. In the State of Rio Grande do Sul, it allows the creation of a learning environment capable of reflecting every actor's experience, and to continuously evaluate the possibilities of adjustments in vision as a continuous learning cycle in the "Gaúcho" innovation system.

Considered as an attractive, compelling and real image of a possible future (Nanus, 1992), the vision marks the beginning of a new trajectory of a university. It comes from a nucleus of leaders who have been able to turn a good idea into an innovative venture. Consequently, it is obvious that the vision of local leaderships marks the beginning of a science park's constitution process. When a vision is shared and accepted, people assume a mutual commitment, feel responsible and are connected by a common aspiration considered important and challenging (Senge *et al.*, 2014). At this stage, when a group of people shares the vision of an organization, each person sees its own image, and start sharing responsibility, not only for its own interest, but also for the whole group. The Porto Alegre Technopole Program generated an environment composed of people who assumed the commitment and responsibility to contribute to the strengthening of the Metropolitan Region of Porto Alegre.

An entrepreneurial university requires a shared vision accepted by the entire academic community (Etzkowitz, 2016). Its organizational positioning is understood as a set of actions, strategies and changes that becomes necessary for the implementation of a vision; mainly encountered in the speeches held by Chancellors, or in the institutional documents, such as the mission, vision, values and principles and strategic planning. Managers become the "locomotives" for change and development. Through a "massification process" of their vision

Category	Sub-category	Descriptors
Community leadership	Vision	Creative and entrepreneurial people
		Vision based on good ideas
		Emergence of new leaderships
	Dissemination	Shared vision
		Attract the interest of people inside and outside the organization
	Positioning	University takes on entrepreneurship as a new mission
		Strategies, actions and changes made to implement the vision
	Learning	Benchmarking
		Communities of practice
		Experience learning
		Informal learning
		Learning by doing
		Learning by interacting

Source: Elaborated by the authors with the Nvivo software

Table V.
Community leadership

and with the use of the words "entrepreneurship" and "innovation," they establish the base that mark a new positioning of the university toward the challenges of a knowledge-based society. Those terms were incorporated by the 2000s, reflecting on the moment where innovation environments pointed toward new alternatives for university performance. Such concepts were recognized as the most effective tools to meet the society and companies' demands to contribute to regional development and to transform it.

The learning sub-category is present in all the formation stages of the community leadership category. It is evident that the *Porto Alegre Tecnópole* Program has played a role in the constitution of the science parks in the State of Rio Grande do Sul and, more specifically, generated strategies by which the leaders learned to constitute their innovation environments in an empirical way, with unique and distinct characteristics. It was possible to identify some strategies used in the learning process of the constitution of the science parks, such as: benchmarking; communities of practice; experience learning; informal learning; learning by doing; and learning by interacting. The lack of conceptual and theoretical knowledge and the few consolidated experiences in Brazil were not impediments to the emergence of Tecnopuc and Tecnosinos. To the contrary, it generated an empirical learning movement that reflected in the emergence of a science parks' network in the state of Rio Grande do Sul.

4.2 Discussion: community leadership as the Fourth Helix, determinant in the constitution of science parks in the State of Rio Grande do Sul (Brazil)

The complexity of the context through which the dynamics of the "Gaúcho" innovations system has developed reveals a new determinant element in the constitution of the science parks in the State of Rio Grande do Sul (Brazil): community leadership.

The Rio Grande do Sul science parks network has not developed according to the prescribed innovation theories and models, but by the direct influence of political, business and university leaderships. This demonstrates a specific incremental path for endogenous development, which arises from the existing resources and opportunities of a specific territory and network, but exclusively limited to its own, by developing itself in a "ghettoistic" manner (Dorion *et al.*, 2018). The actions of the leaders generate an impact and establish an endogenous path for the actors of the project, allowing the resurgence of their own ideas toward a united and common local goal.

Leadership is understood as a process of social construction (Uhl-Bien, 2006; Uhl-Bien and Carsten, 2018). The perspective of social construction requires the understanding of a collective process, which includes a meaning-making scheme of a group to define its direction, to create compromises and to face adaptive challenges (Ospina and Foldy, 2010). Community leadership results from the collective actions and the historical and cultural shared knowledge in a given territory, which allows to understand and to analyze the leadership process for innovation as a collective achievement, a collective work. Leaders that emerged in the Porto Alegre Technopole Program, in 1994, continue to contribute to the constitution of the science parks, by assuming new roles in the institutions or by assuming functions in different institutional spheres. The concepts of "local leader" recognized as a regional innovation organizer or as a regional innovation catalyst, as proposed by Etzkowitz and Zhou (2017), Etzkowitz and Ranga (2015) and Champenois and Etzkowitz (2018) are confirmed. They constitute key elements for the Helix Model, since they explain a movement of continuity and the formation from the leaders in the consolidation of the science parks, which strengthens the performance of the actors and generates community leadership.

Over the last 20 years, both the *Porto Alegre Tecnópole* and the *RS Tecnópole* Program generated a regional leadership that disseminated innovation. It is the result of the interaction between the local actors and the existing knowledge-based potentialities as a

new society, in view of the development of the regions of the State of Rio Grande do Sul. The results show that the innovation process strengthened as the leadership process advanced (vision, dissemination, positioning and learning), by conquering more people, forming more leaders and forming a unique and outstanding network of science parks, at the national and international levels.

Etzkowitz (2016) demonstrates that, in order to institutionalize a new university vision, institutional mechanisms are required. In this sense, the science parks constitute important mechanisms capable of creating conditions for the development of an appropriate environment for entrepreneurship and innovation, which are the result of concerted integrations and generation capacities that unite the different forces of conduction and construction of new paths, embodied in learning processes and institutional improvement.

The research demonstrates that the community leadership category is the result of a due process, characterized by both spontaneous and endogenous movements of local development, which emerged empirically and willingly by the acting leaders that work in different institutional spheres. In accordance, the constitution of the science parks in the State of Rio Grande do Sul occurred from the contribution and the direct influence of leadership actions, mainly from university management.

Figure 1 illustrates the science parks' constitution process in the State of Rio Grande do Sul, considering the concept of community leadership as a key element of the Triple Helix model. The Fourth Helix represents the leadership of the actors, represented by the initiatives and the actions of the local actors who were able to create an effective project process, initiated by the leader's vision on the importance of knowledge in a future society. Their capacity to disseminate a common objective to other people in the organization and to maintain the pace of the project process above their interest individual made them capable of generating the necessary transformations and the positioning of the university to meet a new demand for knowledge, entrepreneurship and innovation. The process of leadership influences the interaction of institutional actors, then distant and with distinct roles and marked by a laissez-faire society, whose productive forces were exclusively in the project environment.

The Fourth Helix is formed by leadership (L), and must be joint to university (U), company/industry (I) and government (G), in a rotation symmetry model that allows the extension of the Triple Helix model, as represented by the adapted scheme of Ivanova (2014).

The Fourth Helix implies a movement of communication and mutual learning. From the adaptation of Ivanova (2014), which inserts the media and society into the Triple Helix model, it is possible to identify six double intersecting areas: LU, UI, UG, LG, IG, LI; four triple intersecting areas: LUI, UIG, LUG, LIG; and a quadruple intersection area: LUGI, which represents the leadership community. The model predicts the existence of different interactions at all intersections, which functions as mechanisms to constitute the science parks.

Community leadership, as a process of "leadership for innovation," influences as a social change phenomenon that ensures the necessary interaction for collaborative work. It promotes relational links between the actors, strengthening existing relationships or generating new interactions (Dorion *et al.*, 2018).

Community leadership is capable of generating and favoring collective actions of the institutional actors of the Triple Helix. It acts as an antecedent for a collective work of interaction between different actors who, until then, were acting individually. Through collaboration, its resources largely depend on its ability to develop partnerships that go beyond its traditional roles of action, taking on the roles of other actors, and overcoming its frontier of action in pursuit of collective action for development.

The once created "leadership community" assumes the establishment of legal, academic and business guidelines for the promotion of entrepreneurship and innovation as an

alternative of regional development. Community leadership is able to create the necessary conditions for innovation, through the creation of innovative environments and the transformation of the territory and the organizations involved. They create opportunities to interact and bring different agents and actors together in a dynamic of knowledge generation for innovation.

Community leadership recognizes the complex interactive dynamics and help to promote a constant flow of information to stimulate them. Community leadership is understood as a powerful change agent.

Science parks are organizations whose relationships and interactions are critical to their success. They are key environments to investigate how leadership allows the necessary connection to build a collaborative environment with different capacities and needs, where knowledge is socially constructed and shared to generate science, technology and innovation.

5. Conclusion

The study about the constitution path of the science parks in the State of Rio Grande do Sul was able to identify the different roles played by the university, government and business actors, as initially proposed by the Triple Helix model (Etzkowitz and Zhou, 2017). However, an in-depth exploration of each dimensions of the model allows to understand its origins and questions the elements that motivated any actions. The outcome confirms the presence of a new dimension of analysis in the State of Rio Grande do Sul: community leadership.

The constitution process of science parks, in the State of Rio Grande do Sul (Brazil), is characterized by unique models, which have their own characteristics. Although all parks are managed and located on the University Campus, each organization has developed its own model, based on its particular characteristics. Consequently, each project has been planned, conceived and managed in a specific way, giving rise to a rich and unique Brazilian experience. The study allowed to identify a series of events that provide relevant historic data on the science parks' creation paths, through an evolutionary perspective of endogenous development, which built a specific identity, a personality of its own, embodied in "ghettoistic" empirical models, as suggested by Dorion *et al.* (2018).

The establishment of the leadership category makes possible to highlight government, enterprise and university managements that contributed to the emergence of the parks through a process of leadership (vision, dissemination, positioning and learning). Such process has required the development of a capacity for continuous learning, whether through experience, communities of practice, interaction and benchmarking, to build their own model of innovation environment. Community leadership has emerged from this inductive analysis approach as the key condition to bring the various actors together, in view of a science park constitution project and, to facilitate an interactive and collaborative work capacity for innovation. It reveals a relationship of interdependence, from which collective actions become an inseparable approach to generate and diffuse innovation.

Such in-depth look at the dynamics of the actors' relationships from the Triple Helix model perspective, which represents a new and different way of looking at community leadership, was an opportunity to understand and to explain how social forces working together can influence organizational behavior and transform a social environment for the construction of new knowledge.

This study put in evidence contributions from a Brazilian perspective. It demonstrates and explains an endogenous development process from community leadership, which generates the interaction necessary to the creation of local science parks.

The empirical and practical implications of this study can contribute to academics, to political, business, civil society managers and science park managers. It can orient them on how to design the necessary conditions for the creation of science parks, by considering and

defining the interactions between the different actors and by assisting the community leaders committed to the development of their community. It can contribute to improve strategies for the development of science parks, in order to strengthen the interactions among the Triple Helix players. It may strengthen the dialogue and collaborations between the national and regional authorities who are interested in creating hybrid organizations and innovation opportunities for regional development.

Such theoretical contribution seeks to enrich the Triple Helix model, by providing a better understanding of the role of leadership in the creation and the development of science parks, thus proposing the addition of a new dimension of analysis to the model, the concept of "community leadership."

In a Brazilian context, the results show that the creation of science parks is not the consequence of a theoretical perspective. It is the outcome and the influence of the goodwill of the local leaders, in an individual and incremental form of endogenous development, explained as the so-called "ghettos of innovation," as proposed by Dorion *et al.* (2018). Consequently, the concept of community leadership is considered as a determining factor, capable of promoting the necessary conditions for the interaction between university, business and government, for the creation and the consolidation of science parks.

Moreover, although leadership is considered as a key factor for the organizations to respond to new daily challenges, there are still few studies realized on the concept of "community leadership" that could support complex organizations' management, more specifically in knowledge-based environments. Although this study as demonstrated a necessity for future research, it focused on the dynamics of community leadership to promote the interaction and the collaboration of different actors in a knowledge-based society. Furthermore, it has given a new path to future studies involving the Triple Helix model, by questioning each dimension of analysis and by understanding the origins and the mechanisms of each action.

Finally, the objective of this case study was sought to understand the science parks' constitution process in its particularities, through the study of the relations between the elements considered significant by the subjects who experienced it, from the managers' positioning to accept and include the concept of community leadership as a Fourth Helix to the Etzkowitz model. Such results may generate practical propositions for the managers who will have to realize complex project, involving knowledge-based realities, more specifically in countries like Brazil.

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