AN ANALYTICAL FRAMEWORK FOR COLOMBIAN SCIENCE TECHNOLOGY PARKS WITH AN APPLICATION TO MANAGEMENT PRACTICES FOR DEVELOPMENT PROCESS STRATEGY.

EFRÉN ROMERO RIAÑO
Universidad de Santander UDES, Santander, Colombia
eromeria@uis.edu.co

LUIS EDUARDO BECERRA ARDILA
Universidad Industrial de Santander, Santander, Colombia
lbecerra@uis.edu.co

GERARDO LUIS ÂNGULO CUENTAS
Universidad del Magdalena, Magdalena, Colombia
gerardoangulo@unimagdalena.edu.co

MARYURIS CHARRIS POLO
Universidad del Magdalena, Magdalena, Colombia.
ingindustrial@unimagdalena.edu.co

ABSTRACT

First generation of Colombian parks, appear spontaneously, second generation receives the recognition of state parks policy but not reach its mature phase of development and the third generation emerges in the context of new sources of state fundings. Own research results show that most of these parks, are not operative and his development has low levels. The most developed of Colombian second generation parks, show two different development orientations, public and private, but no one of these reach its mature phase and generate results that indicate one particular path for development process of this kind of initiatives. This paper analyzes the question: What does it take for Colombian science technology parks for better performance of its development process ?. We propose an analytical framework to examine performance of Colombian parks in incubation phase and identify management practicesg. STP in Colombia were surveyed to identify conditions and factors affecting development process at incubation phase and determine which are critical management practices for them.
Methodology includes methods as case study and technics as structural analysis, semistructured interviews and content analysis. The framework comprises three aspects of a science technology park's development process: development models, critical factors and strategy components. The development model highlight conditions for move into its next phase, critical factors propose underlying variables within Colombian operatives parks and strategy components identify management practices related with operative institution.
Research results includes identify factors by means of literature review and selecting main conditions and factors for Colombian STPs development. Identifying successful management practices for development process of Colombian Parks, is a contribution to its evolution in the country as well as in Latin America and other emerging economies and report one first step for identify lessons learned that can be transferred from operatives parks to projects of parks starting activities.

INTRODUCTION

The essential concept of science park is one spatial development where the interface of research with commerce and industry is encouraged for the better exploitation of advanced technology (Deong- Sung, O y Gi-Don, A., 2012). Definitions of science park development vary considerably around the world and significant variations occur even within individual countries and it's related with institutions definitions, size and scope. In that vein, Science park definition as one institution focused on basic research, is property-based initiative; has formal links with a university or other higher educational and research institution (HEI); is designed to encourage the formation and growth of knowledge-based businesses and other organizations normally resident on site; has a management function which is actively engaged in the transfer of technology and business skills to the organizations on site (Deong- Sung, O and Gi-Don, A, 2012). Science technology park is considered a bigger institution than science park, it incorporates anchor tenant and host firms (startups and spin offs) and is focused on applied research. The regional innovation cluster can be defined as a specific area(s) with networked location(s), where innovating actors are concentrated and interacting, which functions as the source of innovative activities for the surrounding region, and supersedes other areas in terms of innovation competitiveness (Yang, 2009). It is a system for innovation composed of actors, process, interaction mechanism, and culture etc. innovation cluster is the unit of competition and has various advantages in science and technology knowledge production, transfer and utilization.

The construct of strategy for development of science parks has been approached from several points. The first one is found at Singapore's science park analysis and its highlights the three aspects that are critical to an understanding of how a science park operates and grows over time: (a) growth mechanisms—the factors and capabilities that sustain a science park and enable it to grow over time; (b) technological capabilities—the development and strengthening of R&D capabilities and the creation of competitive advantages in specific technology sectors; (c) global role and market integration—the linkages between the region and the global or national economies, the degree of integration with regional or global markets, and the creation of the region's niche in the global system (Koh et al, 2005). Because one of the parks mission is promote innovation and technology transfer from universities to the host firms, there is a need to understand how strategies may affect firm's ability to innovate, even though those strategies are not designed to affect the firm's innovativeness (Westhead and Storey, 1995). In addition, higher education institutions should appreciate the necessity of having an effective managerial structure designed to 'add value' to tenant firms (Löfsten and Lindelöf, 2003).
The second one is focused on conditions to be completed trough the different phases or stages of development. These stages are called: incubation or initial planning, growth or steady growth and maturity stage. Several recent studies assess the relation between performance of science parks and factors such as location, university links and facilities within developed countries, but not includes management practices as central point of performance. The objective of this paper is built an analytical framework for encourage management practices for Colombian science parks development process strategy.

1. Framework

1.1 Management practices

There are many evidences of practice's importance for science parks, for example, it has an interest among policymakers and industry leaders in identifying best practices. This raises important questions relating to strategy formulation by organizations that manage science parks and incubators and also for tenants of these facilities (Phan et al., 2005). Due to management is an endogenous constitutive factor of parks, management practices are tools than can explain better or worse performance in this institutions.

There is a variety of approaches and concepts related to Management Practices Identification at organization level. The first concept to define is a "practice", a practice can be understood (Cf. O'Leary, 2007) as the way an organization develops specific processes. Those practices that have been widely recognized over time as excellent approaches for many organizations, and recommended by a large number of practitioners or experts to adopt successful results, are viewed as good or the best practices (Xu & Yeh, 2010). According to (Bergek & Norrman, 2008), a Best Practice can be defined as a process that is better at delivering a particular result than any other. The word ''better'' can also be understood in two different ways: effectiveness/performance, i.e. whether the right things are done, and efficiency, i.e. whether the things done are done properly. The best practices can be identified and learned from many sources such as industrial experiences (e.g. practitioners), consulting experiences (e.g. experts), advanced information systems (e.g. ERP systems), and knowledge base (Xu & Yeh, 2010). Both, Identifying and transferring practices are extremely difficult processes and there is no consensus among consultants as to the appropriate methods to identify the best practices (Wellstein & Kieser, 2011). Laugen et al (2005) assume that the best performing companies must be the ones deploying the best practices. Their assumption focuses on manufacturing practices; they define best practices as those used for achieving a superior performance. While award-winning organizations are shown as a model of how an organization should be managed, Harrington (2004), based on an international management practice database, suggests what maybe can be good for one organization can actually be disastrous for another. This work does not pretend to identify management best practices in STPs; the main interests are to describe and compare those implemented management practices in Colombian STPs versus other countries. Next, some theoretical aspects are described about STPs and the factors affecting their performance.

1.2 Development process for science parks

A typical STPs development process takes on average ten years and completes three phases: incubation, constant growth and maturity (Allen, 2007). According to Deong- Sung, O y Gi-Don, A. (2013), science parks three stages development are: initial or science park model focus on R&D, business and infrastructure, the middle stage or technopolis model, focus on expand R&D activities into technology commercialization activities and secure R&D capacity of the science park, and the mature stage, Innovation Cluster model, focus on research centered is led R&D activities in national strategic industries, maximize the efficiency of technology commercialization activities, R&D activities and technology accumulation.

Several development patterns and large variety of shareholders and founders of STPs (Phan et al., 2005) have contributed to the formation of very heterogeneous Science Parks (Westhead, 1997), The main difference between them, is focused in the level of commitment of universities in the parks. For example, in the United Kingdom, the most of science parks are university initiatives (Westhead and Storey 1995), however, in the most countries such as Australia, the United States, (Phillimore, 1999), Japan (Fukugawa, 2006), Portugal (Ratinho and Henriques, 2010) this initiatives are government or private directed In that vein, it is possible to identify two types of organizations: Technology Parks (TPs) in which there is no university shareholding, and Science Parks (SPs) in which there is university shareholding (Albahari et al., 2013).

Science parks development process assessment, is considered as performance evaluation by difference focus (UKSPA, 2003). Existing researches evaluate the STPs' performance mainly through the added value on tenant firms (Lindelöf & Löfsten, 2002). Added value is estimated by comparing indicators such as number of created jobs, sales and profitability (Lindelöf & Löfsten, 2004) and also innovation outcomes (Detweiler et al, 2002) on samples of firms inside and outside STPs. The most these researches are made in developed countries as U.S.A. (Phan et al, 2005; Link & Scott, 2003), Sweden (Lindelöf & Löfsten, 2002-2004), Russia (Kilgren, 2003; Radosevick & Myrzakhmeth, 2009), U. K. (Allen, 2007), and Japan (Fukugawa, 2006). These works explore the effects on STPs' performance of certain factors (e.g. age, location, university-enterprise links, and administration). Almost all of the STPs under study were in a mature stage; we did not find relevant literature about STPs in early stages.

The reviewed literature shows that science parks development process, focused mainly by a linear conception of the relationship between science and innovation and a concept of science parks as providers of facilities, may be replaced by an interactive, dynamic and network-oriented and may be to cater for the development of the social capital necessary for enabling and facilitating entrepreneurship in networks (Hansson et al., 2005)

The development process of STPs has been little studied (Camacho et al, 2013) in the context of both developed and emerging countries. Studies in this area include countries such as Italy (Colombo & Delmastro, 2002), Portugal (Ratihno & Henriques, 2010), Taiwan (Yang et al, 2009) and Greece (Sofouli & Bonortas, 2004, Bakouros et al, 2002). These studies highlight the importance of factors such as administration, relations with universities and knowledge generation (Sofouli & Bonortas, 2004) for parks development and economic context of the countries where they are located.

1.3 Strategy

Strategy is one of the facilitators of the organizational excellence according to the EFQM Excellence model EFQM (2009a, 2009b, 2009c, 2009d). Under the term of "strategic planning" is one of the criteria for organizations assessment in the Baldrige model (NIST, 2011a, 2011b, 2011c). Also strategy appears as the category of processes called "Developing a vision and strategy" in the framework APQC-PCF (APQC, 2010) and is considered in the PWC-PCF framework (PWC, 2011) within operational processes as "developing the vision and strategy".

According to Bigliardi et al (2006) official statements are often not a useful starting point for identifying the current "mission" and the goals of STPs. In most cases, the business model and the strategic behavior of a PCT is influenced by implicit strategies that do not necessarily coincide with the missions and goals that have been formally declared. The mission and, therefore, the “real strategy" only arises after the STP has existed for a period of time and has taken advantage of the opportunities that have been offered it, has created its own "living space" and consolidated its structures.

According to Koh et al., (2005), the strategy represents a new alternative for Singapore’s science parks development based on three factors, strengthening of its technological capabilities, developing its growth mechanisms, and linking itself to global markets—in short, becoming a self-sustaining hub for R&D and innovation. This strategy can becomes in new Sigapore`s science parks chance for success and better performance.

On the other hand Finland understood a technology- and innovation-oriented growth strategy to be necessary, as increasing exposure to foreign competition required world-class innovative capacity, efficiency, and value-adding capacity (Schienstock and Hämäläinen, 2001). They achieved consensus on a new growth strategy that emphasized technology and innovation (Ministry of Trade and Industry, 1996). In sum, Finland’s prowess derives from the following factors: a horizontal organizational structure and emphasis on cooperation and collaboration; clear roles and tasks for all actors in innovation processes; clear and firm common goals established through national consensus-building among all actors; a comprehensive approach to national and regional innovation systems; and a mechanism for sustaining the innovation system based on investment, innovation, assessment, and cooperation (Schienstock and Hämäläinen, 2001). Thus, as industry and universities took up a technology- and innovation-oriented growth strategy, the government set policies and programs to enhance their efficiency and competitiveness (Sang-Chul, 2004)

1.4 Growth mechanisms

Umer Wasim proposes four domain for science park planning: governance, external factors, sustainability and growth and in addition, claims that the concept of growth, focused on functional specification of a science park, have been compounded for five factors (Umer Wasim, 2014): incentive, location, networking, business support, and infrastructure.

Koh. et al,. (2005) highlights that growth mechanisms, are the factors and capabilities that sustain a science park and enable it to grow over time. Growth of a science park is enabled by the services it offers to its target group. Commonly these services include: networking support throughout its value chain, infrastructure for desirable quality of life and work ambience, access to opportunities that lie inside/outside a science park, economic incentives, access to eminent organizations, and culture with general familiarity with entrepreneurial behavior and ethics (Umer Wasim, 2014).

On the other hand, Koh (2005) claims that the growth factors are broadly classified into subgroups: (a) gestation and takeoff factors, which provided the initial impetus for the exemplar’s establishment and development; (b) growth sustaining factors, which are the capabilities that enable the science park to renew and sustain itself. Gestation and takeoff factors includes gestation and early advantage, evolution and constraints and the growth includes sustaining factors, tenants, R&D stages contained within park or region and additional enabling factors (Seely Brown and Duguid, 2002).For Lee et al.,(2000). the single most critical factor

for a science park's long-term sustainability is its ability to foster the creation of new firms, in both existing and emerging sectors, in order to continually renew itself. This is considered the key factor in Silicon Valley's success.

We can discern three types of growth mechanisms: (i) government-directed mechanisms, in the form of infrastructure provision; (ii) agglomerative effects; and (iii) new-firm creation and self-renewal. We consider these growth mechanisms in turn Koh (2005). The first one, involves the funding of institutions of research and the development of high-quality infrastructure, the second one, the existence of cluster of high-growth technology firms, access to a greater number and variety of suppliers, technical expertise, and potential business partners Xue (1995) and third one ability to foster the creation of new firms, establishment of incubators and colocation of venture capital and the presence of world-class universities and other research institutions (Saxenian's,1994).

1.5 Technological capabilities development

In a broad sense, we define technological capability as the capacity to gain an overview of the technological components on the market, assess their value, select which specific technology is needed, use it, adapt and improve it and finally develop technologies oneself**.** (Jörg Meyer-Stamer, 2010). Technological capabilities are related with the development and strengthening of capabilities in R&D and the creation of competitive advantages in specific technology sectors (Koh, 2005) and refers to the level of research or technology development capabilities within a science park

The development of R&D is the core of initial phases of sciences parks and according to Quintas et al. (1992), the model of technological development which lies at the core of the Science Park is essentially a linear model. The model suggests that the outputs from basic research provide a knowledge base which can be drawn upon by bodies undertaking applied research and experimental development. According that, much attention has been focused on two crucial policy issues which emerge from the linear model: i) how to maintain the supply of scientific ideas and knowledge and ii) how to more effectively link together the various stages of the innovation process.

At this point, Amsden and Tschang (2003) presented one typology that consists of five categories for R&D stages range: i) pure science, ii) basic research, iii) applied research, iv) exploratory development and prototyping, and to advanced development (manufacturing).

2. Methodology

2.1 Methods

For the development of this research, the case study methodology was selected due to the emerging nature of the subject within the scientific literature (Yin,2003) and limited information about the Colombian STPs. Additionally, due to the analytical approach addressed in this research, the guidelines set forth in (Eisenhardt, 1989) are included. This work can be classified as a multiple case study (Yin, 2003) and is focused on the five STPs recognized by Colombian STPs Policy.

2.2Techniques

This multiple case study considers the application of the following techniques: (i) written questionnaires, (ii) semi-structured interviews and (iii) content analysis (Piñuel, 2002) . The questionnaires ask about the management practices of the STPs and related with the growth mechanism and technological capabilities of their own development process. Interviews include STPs founders, managers and consultants involved in the development of feasibility studies of Colombian STPs projects and initiatives. Study results include the identification (by the literature review) of several factors around of Colombians STPs strategy for development, and the identification of their importance from the point of view of STPs' leaders and managers.

2.3 Problem statement

The Technology Parks have played an important role in the consolidation of clusters in developed economies, as in the case of Sophia and Innovalle Pole TP in France where the cluster of electronics industry developed. In emerging economies such as Mexico and Brazil, the importance of focusing on TP that have served as an instrument of regional development and to encourage the growth of new sectors of the economy. Moreover, a typical development process must take to a TP on average 15 years. During this time he must have attained maturity. In Colombia, 13 years ago, the national policy was formulated PTs and early development studies were conducted five TP. Only two of these initiatives, survive nowadays: the PTG and the PTA. The principal reason of this facts, may be related to development strategy for science parks.

In that vein, we formulate the main proposition: PTs initiatives in Colombia has not reached its maturity phase, due to its development process strategy. Several questions are derived, the first one, What are the most studied factors and best practices, for the development strategy for PTs initiatives within the scientific literature?, the second one, What are the factors that can be identified as distinctive within the strategy of development of technology parks initiatives in Colombia? and the third one, What good practices have been used to implement the development strategy within technology parks initiatives in Colombia?.

3 An application of the analytical framework to Colombia

3.1 Colombian Science Parks development

Several groups of cases were selected for the framework application about development process and analysis of Colombian parks, the first one, the most developed operative parks, Gautiguará and Biopacífico (PTG and PTB) and recently restarting parks, Antioquia and Sabana (PTA y PTS). (Angulo, Camacho, Romero, 2014). The first aspect of our framework is the set of growth mechanisms that drive a science park's development. PTG and PTA show greater progress in its development process. PTA, have fulfilled certain conditions of second phase park or growth, showing an orientation towards private funding mechanisms and administration, but failed to incorporate research in their facilities or consolidate an area of R & D within the park to strengthen transfer technology (Table 1 and 2).(Romero, Camacho, Angulo,;2014). Considering the fulfillment of conditions set out in the models, the level of development of PTG are classified as incubation stage or park model.

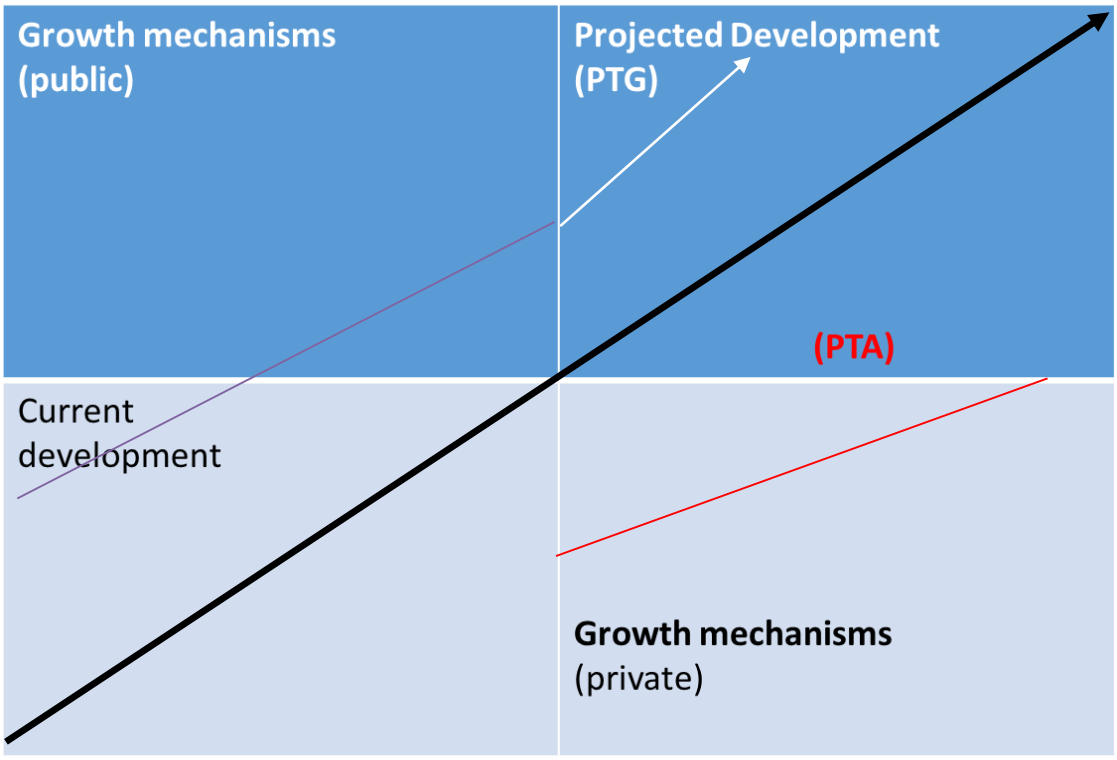
Table 1. Analysis of Colombian parks development around Deong-Sun Model

	Features		PTA	PTG	PTS	PTB
Funtional Model	science park model	Generation of start-ups for research	x			
		Transfer of research activities of universities to PT		x		
		Establishment of incubation centers	x			
		Improving growth and expansion of R & D in the PT		x		
	Technopolis Model	More specialized management and operation				
		Support incubation activities			x	
		Collaborative research between companies and universities	x	x		x
		Articulation between companies and investors	x			x
	Innovation Cluster model	Accumulation and commercialization of technology through collaborative research				
		Incubation support infrastructure				
		Desarrollo de infraestructura comercialización de tecnología				
		R & D centers with official		x		
		Education and development in areas of PT				

Table 2. Analysis of Colombian parks development around Allen Model

Feature		PTA	PTG	PTS	PTB
Incubation	Initial planning	x	x	x	x
	Agreements between stakeholders	x	x		
	Funds for start	x	x		
Growth Steady	Prerequisites for joining the PT-Research Centers		x		
	Prerequisites for joining the PT-Business	x	x		
	Location-Infrastructure	x	x		
	Established quality management		x		
Matiurity	Regional technological development				
	Regional economic development				

Figure 1. Orientation growth mechanisms of Colombian technology parks



3.2 Colombian Science Parks development strategy

The analysis of the development strategy of the Colombian science parks, is implemented through the identification of matches in two factors pointed in the framework, growth mechanisms and technological capabilities. With reference to the components of growth mechanisms and level of development for technological capabilities of the two most developed Colombian technology parks, PTG further guidance to identify the mechanisms of growth of public and governmental origin, while the PTA shows an orientation to private mechanisms (figure 1).

Table 3. R&D Categories of Colombian technology parks

R&D Categories	**PTG**	**PTA**	**PTS**	**PTB**
Pure science	**x**		**x**	**x**
Basic research	**x**	**x**	**x**	
Applied research	**x**	**x**		
Exploratory development and prototyping	**x**			
Advanced development (manufacturing).				

In addition, the level of development of technological capabilities of Colombian parks shows that considering the R&D categories, no one of Colombian parks have achieved advanced

development categories and the most usual for them is basic research (Romero, 2015). The PTG generates results in all categories and in recent days they have been granted eleven patents in different areas of knowledge, positioning itself as the third university in the country with the largest number of patents. In reference to the PTA, its level of development of technological capabilities focuses on applied research results getting several patents mainly in the biotechnology industry (Table 3).

3.3 Management practices for development process strategy.

In general, the practices commonly implemented in the analyzed STP s correspond one to Government directed mechanisms and the other one, to Basic Research. In terms of government directed mechanisms, the practice called quality infrastructure is the most implemented, resulting in consolidate infrastructure and research teams to attract top-level research institutions on park but with small differences in orientation, the PTA focuses on foreign research centers links and the PTG focuses on technological development centers links with national spectrum.

Table 4. Management practices identified within Colombian Parks- Growth mechanism

Factor / Government directed mechanisms	Practice	Description	STP
Funding of institutions of research	Mixed financing	Financing through public calls and resources	PTG
Development of high-quality infrastructure	Shared research infrastructure	Construction of laboratories under the scheme Flex Lab	PTG
Development of high-quality infrastructure	Quality infrastructure	Consolidate infrastructure and research teams to attract top-level research institutions consolidated	PTG-PTA
Agglomerative effects	Practice	Description	STP
Existence of cluster of high-growth technology firms	Internal clusterization	Internal clusterization of own research centres on park.	PTG
Access to a greater number and variety of suppliers	Tenants fundraising for Infrastr. and equip.	Unidentified	PTG
Ability to foster the creation of new firms	Practice	Description	STP

Ability to foster the creation of new firms	Anchor firms	Alliances for locating institutions dominate position within a cluster	PTG
Establishment of incubators and colocation of venture capital	Dedicated staff for incubation	Unidentified	
Presence of world-class universities and other research institutions	One or few shareholders	Only university management Incorporate technological development centers	PTA

On the other hand, about technological capabilities management practices, the most implemented practice is generate outputs usually in scientific journals. This situation is reinforced by observing the number of publications and position of universities or the reason that both managers universities have increased their number of publications of articles and held within four most important country in that area.

Table 4. Management practices identified in Colombian Parks Technological capabilities-

R&D Categories / Pure science	**Practice**	**Description**	**STP**
Techniques and results	Specialization in use of the latest technology	Training in associated techniques for specialized equipment	PTG
Motivations	Motivated researchers to sell scientific services	Positioning services based on technological acquisitions	PTA
Basic Research	**Practice**	**Description**	**STP**
Motivations	Generate Outputs usually in scientific journals	Positioning of research institutions based on the number of articles and citations	PTA-PTG
	Generate Outputs usually in patents	Improving the propensity to patent	PTG
Factor applied research	**Practice**	**Description**	**STP**

Transforming or localizing existing product knowledge	Link anchor firms on park	Alliances for locating institutions dominate position within a cluster	PTG
Reapplying known research results to other areas	Joint work between research groups	Development of joint projects for the acquisition of state resources	PTA
Exploratory development and prototyping	Dedicated staff for incubation	Unidentified	
Advanced development	One or few shareholders	Only university management	PTG
	One or few shareholders	Incorporate technological development centers	PTG

The analysis of conceptually opposing practices shows in advanced development R&D categories two different approaches, the first one is identified in the PTA and refers with various partners on park, including universities and private sector partners, while the PTG maintains a focus on one or a few partners on park, through one strong institutional commitment from its university manager, the Universidad Industrial de Santander..

4. Discussion of Results and conclusions

The concept of development strategy of technology parks is an emerging issue in the scientific literature and therefore one of the constraints to the development of this work is the lack of availability of information. The "strategy of development" of the PTG is defined in two areas: growth mechanisms of the park and the strengthening of its technological capabilities and research. The PTG has implemented growth mechanisms based on mixed financing resources from state resources, own resources and public announcements. The development of quality infrastructure, has been a common factor in management practices and strategy of technology parks Colombians, but this practice is insufficient for the acceleration of their development.

Similarly, within the model of analysis of technological capabilities based on the categories of advancing R & D, the most implemented management practice is the management of outputs for research in scientific papers but low propensity is observed in product development and patents. This situation can be caused by the lack of clear rules for researchers regarding the generation of enterprises and economic returns of the same given its status as state employees.

The practices identified in this research, high relevance and effectiveness for the development of the PCT in Colombia are: diversification of funding sources, development of international missions, partnerships with established research centers, transfer of research to the park the consolidation of a critical mass on the subject of parks within universities and research infrastructure building world class.

The main objective of this study was to identify what doesit take for Colombian science technology parks for better performance of its development process. This work contributes to the understanding of the phenomenon of PCTs in developing countries, specifically in the case of Colombia. They have identified as the most prevalent management practices around technological capabilities and growth mechanisms. This finding are consistent to the management practices raised by definitions and models for first and second phase of development STPs, which is the current state of development of the Colombian parks. The identification of these practices, provides an approach for in-depth analysis and identification of management practices that have positively influenced the development of both, STPs that are in their first phase (PTC , PTS and PTB) and those who are in developing phase (PTA and PTG).

According this research results, highlights that PTs initiatives in Colombia has not reached its maturity phase, due to its development process strategy. About what are the most studied factors for the development strategy for PTs initiatives we find that the capabilities and growth mechanism are the most studied. The factors that can be identified as distinctive within the strategy of development of technology parks initiatives in Colombia match to public oriented growth mechanism for PTG and private oriented growth mechanism for PTA. Future research can be oriented toward identify lessons learned for development process strategy of Colombian Science Technology Parks initiatives.

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