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Populating the Garden: The growth of Research, Science and Technology Parks, Lessons Learned for Future Projects in the Developing World

Parallel Session 6
"The future: lessons, methodologies and new to-dos"

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INTRODUCTION

Research, Science and Technology Parks (RPs) have been a growing phenomenon for the last 60 years that now it is also being seen in regions with no previous experience in the field. Currently, there are more than 800 parks around the world, with the highest amount of parks concentrated in traditionally known technology producer regions like North America, Eastern Asia, Northern and Western Europe. Countries from these regions house about 90% of the world population of RPs.

More than 60 of new RPs developments have been computed to be in 37 different countries across the world, 10 of these countries are first time players in adopting the Research Park strategy. A high proportion of these new parks (30%) are being constructed in countries with no previous experience in technological innovation or not depending on a knowledge-based economy before, in regions like Latin and Central America and Northern Africa.

The importance of Innovation and TT for a sustainable economy in the developed world is now more evident to developing countries. For them, the need to understand and implement knowledge-based entrepreneurial activities is not an option but an urgent need. More governments are including RPs as part of the regional and national innovation systems to overcome underdevelopment and poverty. In 8 Latin American countries, 60 RPs are now operating; most of them new, started just after year 2000. Another 45 new RPs are in the completion stage, not yet fully operational.

Evidence of higher employment rates based on RP's initiatives can take years to present tangible results, most likely when parks reach "maturation stage". Therefore, it is yet unknown the impact these relatively new parks will have in the economic development of these countries.

These countries; regardless of geographic location, culture, ideology, or political beliefs, and, in some cases, with a tradition of a high economic dependency on non-renewable natural resources like oil or agricultural wealth; are investing substantial public funds to develop or improve their productive structures and have adopted the Research Park strategy to boost their economic growth. As these are long-term projects and the results are only seen after decades, several questions arise pertaining to in what ways technological innovation initiatives should be followed.

Research parks through incubation of emerging technology companies and generation of high quality jobs have also proven to be effective agents for economic growth in regional innovation systems (Batelle, 2013). Several studies have been conducted on technological innovation and RPs, and these present different points of view on this complex process as it has been occurring in the United States, United Kingdom, Germany, Belgium, Spain and other European and Asian countries (e.g., Athreye, 2002; Lofsten & Lindelof, 2002; Storey & Tether, 1998). Most of the data available is for OECD countries (OECD, Science, Technology and Patents, 2014). However, few studies address RPs and technological innovation for developing countries, with the exception of

China and India. Except for a very few studies focusing on Brazil, Chile and Mexico, the body of knowledge for the rest of Latin America is still embryonic (Rodriguez-Pose, 2012).

Recent studies convey new dimensions for the analysis and study about RPs and, as the population of parks grows worldwide, the complexity of these analyses also increases. RPs were seen mostly in the developed world but they are now present in countries at all stages of economic development; as their performance is dissimilar thus stimulating an important academic debate whether the RP initiative is an effective catalyst of innovation.

This study analyzes the growth of RPs around the world and points to the basic characteristics of a successful innovation ecosystem from the view point of RP's directors surveyed from 130 RPs from North America, Asia and Europe. Could these "best practices" be used as learned lessons for starters of new RPs projects in the developing world?

The implications for a developing nation wanting to invest in and pursue this path have not been deeply explored, there are uncertainties about the necessary components and resources to have in place so these investments bring about positive results. Lessons from the North American, European and Asian countries with a considerable experience with research parks could be potentially applicable to new projects by starter countries in other parts of the world. However, region specific characteristics that make these differences significant and could influence the performance of research parks need to be taken into consideration before replicating or adapting what are known as best practices, to other countries.

These considerations are important, as they could allow champions of new projects, policy makers and planners in starter nations to understand how technological innovation occurs in its wider context and take the right steps when designing and implementing new or existing projects.

1. FRAMEWORK AND METHODOLOGY

The overall goal of the present research was to determine the differences in how managers and directors of RPs across the world evaluate their parks' efficiency and effectiveness. The research focuses on factors that have a positive influence on the technological innovation process, which hence could be categorized as "best practices".

The effectiveness was measured by assessing the research park's contribution to economic growth and job creation in the locations of RPs. The efficiency of RPs was measured with respect to three general aspects, as follows and in no order: the first two regard the presence of basic characteristics and degree of the culture of innovation in the ecosystem, and the third, exclusively for university-based RPs, addresses the interaction between the university and the research park (Luger & Goldstein, 1991).

Design of the Study

The data collection instrument was a cross-sectional survey of all participants using an online self-administered questionnaire, the *Survey for Research, Science and Technology Parks* (SRSTP*),* this survey consists of the 25 questions itemized in Appendix A. The questions from the survey were inspired and adapted from the work of Luger and Goldstein (1991), who studied the U.S. RPs and their expected regional development outcomes, under the lenses of different theories: 1) growth pole/growth center and innovation diffusion theories, where emphasis is given to the relationships with industries or individuals; and 2) entrepreneurship and regional creativity theories, which prioritize places or individuals.

Luger and Goldstein (1991) predicted a set of regional development outcomes from RPs by combining the mentioned theories with previous results from empirical studies about R&D location and technology diffusion. Figure 3.1, shows a classification of possible primary and secondary impacts of RPs.

Primary impacts referred to the change in the magnitude of the activity while secondary impacts affect the structure; the most important impact refers to the increment of R&D activities in the industries within regions where RPs are located, taking advantage of the availability of specialized labor force, facilities, research institutions and particular types of social and cultural environments.

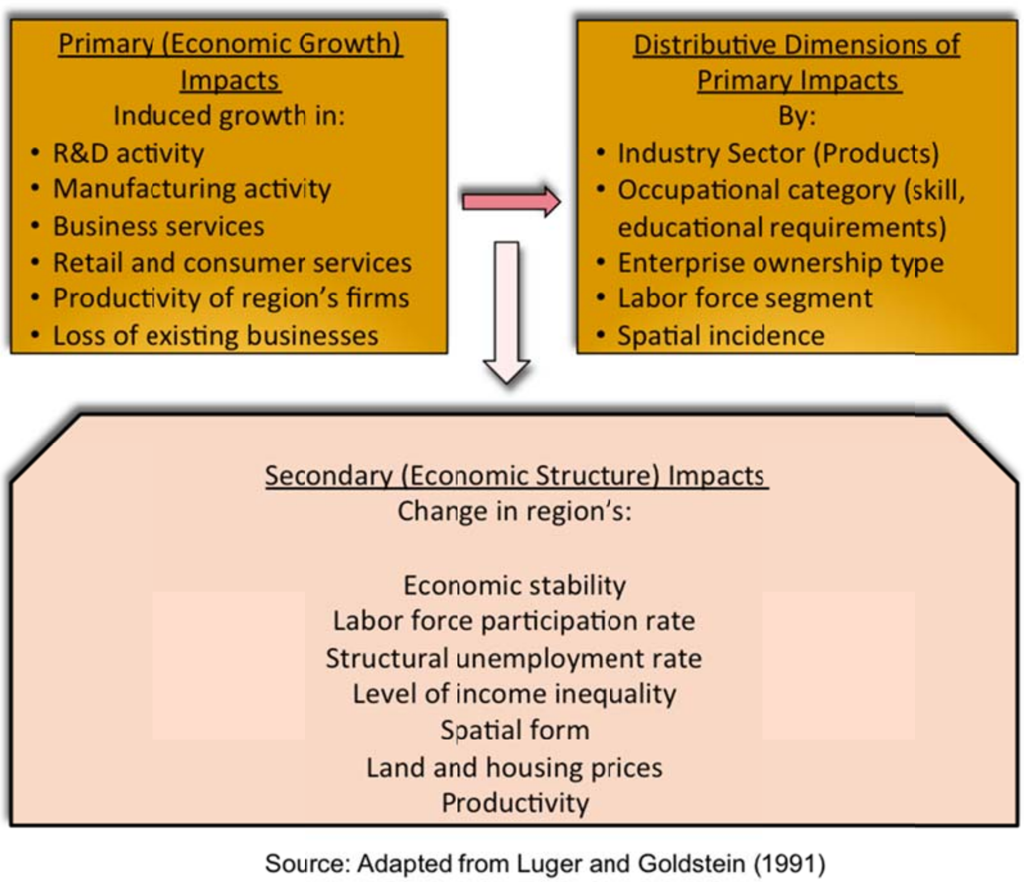


Figure 1-1 Potential RP's impacts on Regional Economic Development

Five sections compose the survey instrument; items in section I are mostly demographic questions, intended to determine the demographic characteristics of RPs participating in the study, including the country --and the state, for RPs in the U.S.-- where the park is located, and the ownership of the park, to differentiate university from non university-based RPs. The goals for each of the demographic questions are detailed in Table 1.1 below.

Table 1-1 Itemized Survey Objectives for Section I

Question	Objective/Purpose of demographic items
1.	Demographic characteristics of participants: geographical location/region
2.	Demographic characteristics: Location state (For U.S. parks only)
3.	Filter question, to determine operating, developing and planning RPs projects
4.	Demographic characteristics of the sample: urban setting
5.	Filter question, to select participants from university-based research parks

The items used from sections II through V, to assess RPs' effectiveness and efficiency, are based on the work of Luger and Goldstein (1991) and adapted by the researcher for a broader and more diverse target population. The objective of items from section II is the evaluation of the park's effectiveness, measured by its contribution to economic growth and job creation. This section is displayed to all participants regardless of the park's ownership and location. It helped to determine if significant differences exist between RPs across the world regarding their contributions to technological innovation and their role as catalysts in the economy of the regions where they are located. The aspects assessed in this section are: the prevalence of local professional workers employed by tenants, the influence of the park in attracting tenants, scientists, students and sponsor research to the area, and the park as a job source for university students and graduates.

Items in section III have the objective to assess the mutual influence or interaction: University - Research Park, this section starts with a filter question, the survey displayed items in section III for university-based RPs only, otherwise the participants were taken to the next section. The items in this section were intended to measure the following aspects: the effect of the park in the quality and visibility of the university, generation of sponsor research from government and industry, faculty activity as entrepreneurs, the park as a magnet for researchers and students coming to the university, and the tenant's trend to hire from university professionals and students.

The goal of items from section IV is the appraisal of the efficiency in the characteristics of the innovation ecosystem, this section was displayed to all participants regardless of park's ownership and location, it helped to determine if significant differences exist between RPs across the world regarding the presence of the elemental building blocks or fundamental innovation components and agents in the area where park is located.

The aspects evaluated in this section are: accessibility to venture capital for start-up creation; the characteristics of public services, transportation, primary and secondary education; presence of non-professional workforce, the intellectual property regulations available, the existence of high-tech based SMEs in the area and the availability of an anchor institution, public or private, within or close to the park.

The objective of items in section V is the assessment of the efficiency of the culture of innovation. This section was displayed to all participants regardless of park's ownership and location and helped to determine if significant differences exist between RPs across the world with respect to the entrepreneurial potential and condition of the fundamental components to nurture the process of technological innovation.

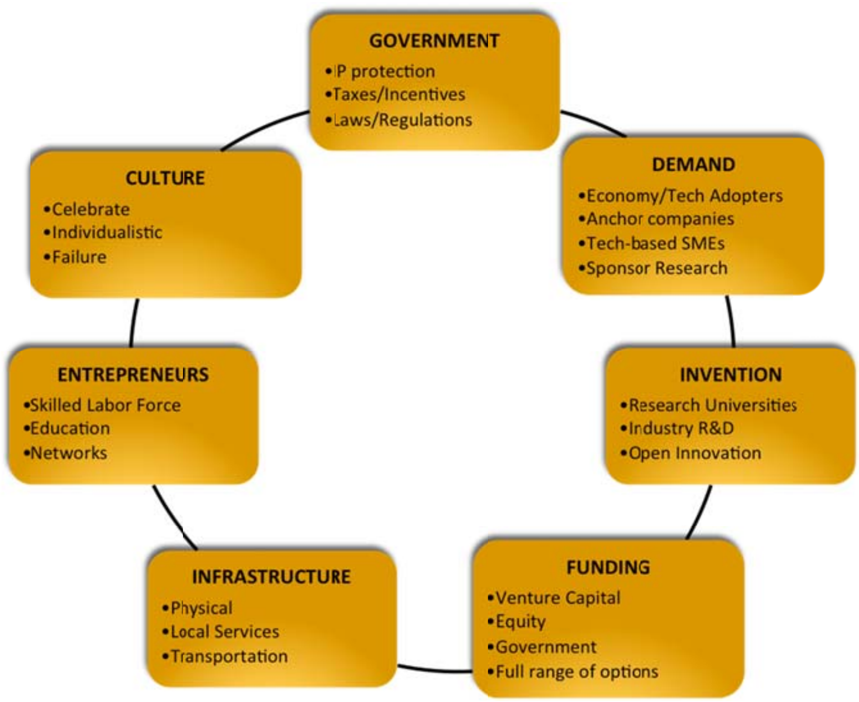


Figure 1-2 Systems View: The Innovation Ecosystem

Source: Adapted from Bill Aulet, MIT Entrepreneurship Center

The aspects assessed in this section are: opportunities for social and informal interaction of entrepreneurs and innovators, characteristics of the majority of the workforce, local availability of profitable research results, networking among tenants, and finally the entrepreneurial culture of the population.

Objectives for each of the sections II to V and questions 6 through 25 are presented in more detail using Table 1.2, and the structure of the questionnaire is represented using The Innovation Ecosystem representation from Figure 1.2. The survey instrument was designed with a bipolar Likert-type scale with a neutral position, using five points between the two extremes to measure the response variable as follows: *(1) strongly disagree, (2) disagree, (3) neutral, (4) agree, (5) strongly agree*.

Table 1-2 Survey Objectives for Sections II through V

Section	Questions	Objective/Purpose of sections
		Effectiveness
II	6 to 10	Participant's evaluation of the effectiveness measured by the contribution in the economic growth and job creation
Section	Questions	Efficiency
III	11 to 15	University-based RPs participant's evaluation regarding the interaction: "university - research park"
IV	16 to 20	Participant's evaluation regarding the characteristics of the innovation ecosystem
V	21 to 25	Participant's evaluation regarding the cultural of innovation in the ecosystem

Population

According to published directories from associations worldwide like the International Association of Science Parks and Areas of Innovation (IASP), the United Kingdom Science Parks Association (UKSPA), the Association of University Research Parks (AURP), the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the Asian Science Parks Association (ASPA), among other organizations, as well as through an extensive online search, the world population of research, science and technology parks totals approximately 874; at the time of this study. This number includes 64 RPs that are in the construction process, but already have an administrative board in place (IASP, 2014). The database for this study was collected by accessing online published data from these associations of RPs in North America, Asia and Europe; the information was cross referenced, analyzed and completed taking into consideration that not every RP is affiliated with an organization and some RPs are members of more than one association.

These directories list other types of organization members, not all of them RPs; these members include service providers, material suppliers, technical assistance, planners, designers, architects, and training providers, which were not taken into consideration in creating RPs population database. While in the process of refining the population list, included items were decided based on whether they contained the words science, research, and technopark or technology park. In those cases where data was not evident or clear, in order to not exclude a park more information was obtained directly from web pages. Whenever two or more similar names were found in the directory, the exact address was used to eliminate duplicates.

Table 1.3 shows the world population of research, science and technology parks, which were allocated using the distribution and composition of geographical (continental) regions and sub-regions of the United Nations Statistics Division. According to data gathered from the total population, 401 parks are located in Europe, 234 in Asian countries, and 158 in North America; the RPs in these three regions account for 91% of parks worldwide.

The remaining 81 parks, about 9% of the total, consist of 38 located in countries from South and Central America, 33 in African countries and the remaining 10 located in Oceania; most of these RPs are concentrated in a very few regions, as is the case in Northern Africa (16), or owned by a few countries, as is the case in Brazil (19), Australia (9), South Africa (7), among others. The distribution of RPs by continent is presented graphically in Figure 1.3.

*Table 1-3 World Population of Research, Science and Technology Parks**

AMERICAS		EUROPE				ASIA			
North America		Northern E.		Western Europe		Eastern Asia		South-Eastern A.	
USA	158	U.K.	99	France	61	China	97	Malaysia	8
Canada	21	Finland	30	Germany	18	Japan	23	Philippines	3
Central America		Sweden	22	Belgium	8	S. Korea	19	Others	5
Mexico	5	Denmark	11	Netherlands	8	Taiwan	5	Western Asia	
Others	4	Estonia	4	Switzerland	8	Hong Kong	2	Turkey	15
South America		Others	11	Others	7	Southern Asia		S. Arabia	8
Brazil	19	Southern E.		Eastern Europe		Iran	21	Israel	5
Others	9	Spain	31	Russian F.	22	India	5	Others	18
Americas: 217		Italy	15	Poland	15	Asia: 234			
OCEANIA		Greece	10	Slovakia	3	AFRICA			
Australia	9	Portugal	9	Czech R.	2	South Africa	7	Morocco	4
N. Zealand	1	Others	5	Others	2	Algeria	5	Others	17
Oceania: 10		Europe: 401				Africa: 33			

*Includes 64 RPs being developed and having a functioning administration body: Spain (13), Brazil (5), Slovakia (3), Saudi Arabia (3), China (3), Mexico (3), USA (2), Portugal (2), Poland (2), Ecuador (2), and 25 other countries with (1) RP.

Source: Author, Cross-referenced from public databases, ASPA, AURP, IASP, UKSPA, UNESCO

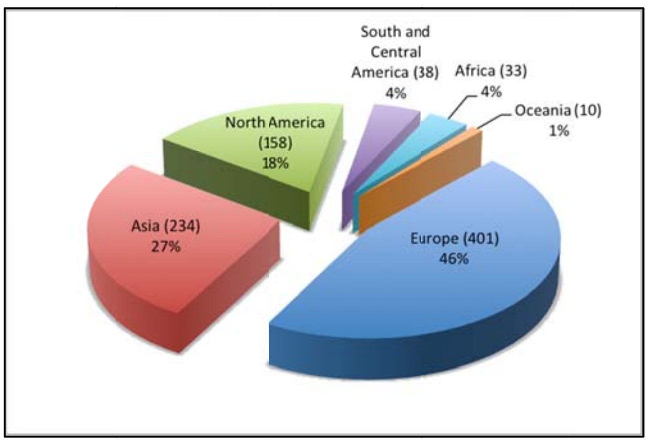


Figure 1-3 World Distribution of Research Parks by Continent

Source: Author, Cross-referenced from public access databases

13 RP new projects are located in Asian countries; 2 RPs are being built in African countries, which are developing a park for the first time; and the remaining 3 new parks are under construction in North America. Table 1.4 shows the distribution by region of the 64 RPs in construction. They are located in 36 different countries, 11 of which are building a research park for the first time and have no previous history of RPs. 50 % of these new projects (31) are being developed in Europe, and the Americas are building almost 30% of the new parks, with the majority of new projects, 15 RPs, located in Central and South America. This illustrates that more countries in this part of the world are adopting the research park strategy. Figure 1.4 below shows the distribution of these new projects by continent.

Table 1-4 World New Projects of Research, Science and Technology Parks

AMERICAS				EUROPE				ASIA	
North America		South America		West. Europe		Northern E.		Western Asia	
USA	2	Brazil	5	Austria	1	Denmark	1	S. Arabia	3
Canada	1	Ecuador*	2	Belgium	1	Estonia	1	Armenia	1
Subtotal	3	Colombia	1			Lithuania	1	Azerbaijan	1
Central America		Paraguay*	1	Subtotal	2	Subtotal	3	Kuwait	1
Mexico	3	Peru*	1	Southern E.		Eastern Europe		Oman	1
Nicaragua*	1	Uruguay*	1	Spain	13	Slovakia	3	Syria	1
Subtotal	4	Subtotal	11	Portugal	2	Poland	2	Eastern Asia	
Americas: **18**				Greece	1	Bulgaria	1	China	3
AFRICA				Italy	1	Russian F.	1	South-Eastern A.	
Tunisia*	1	Nigeria*	1	Serbia	1	Subtotal	7	Thailand	1
				Macedonia	1			Southern Asia	
				Subtotal	19			Iran	1
Africa: **2**				Europe: **31**				Asia: **13**	
*Countries building a Research Park for the first time									

Source: Author, Cross-referenced from public databases, ASPA, AURP, IASP, UKSPA, UNESCO

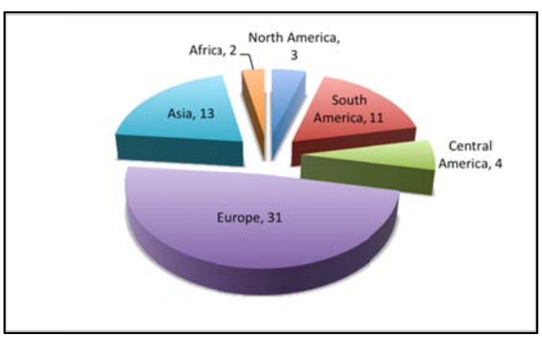
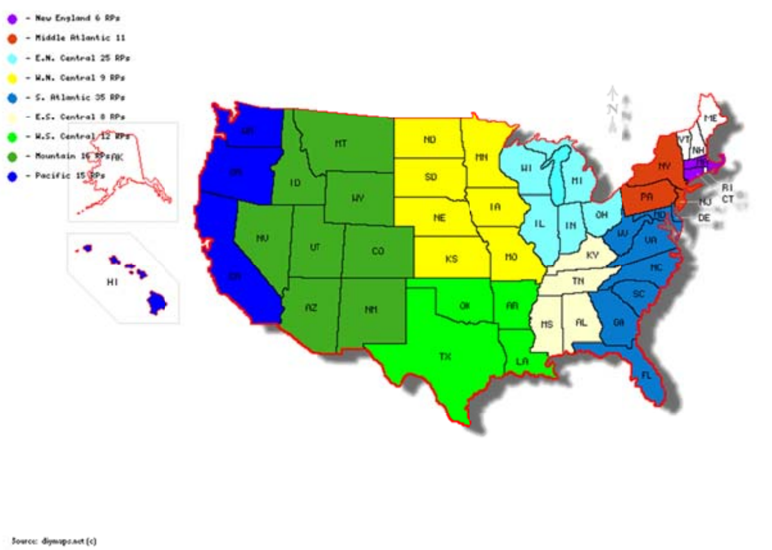


Figure 1-4 New Research Park Projects by Continent

Source: Author, Cross-referenced from public access databases

A total of 134 countries out of the 217 countries recognized by the United Nations do not have a research park. Most of these countries, 45 (33.5%), are located in Africa, 27 (20%) are in the Caribbean region, 11 (8%) are in Central and South America, 23 (17%) are located in Europe, 23 (17%) are Asian countries, and 1 country is in Oceania.



Region 1: Northeast		
New England		6
Middle Atlantic		11
Subtotal	12 %	17
Region 2: Midwest		
E. N. Central		25
W. N. Central		9
Subtotal	25 %	34
Region 3: South		
S. Atlantic		35
E. S. Central		8
W. S. Central		12
Subtotal	40 %	55
Region 4: West		
Mountain		16
Pacific		15
Subtotal	23 %	31
TOTAL	100 %	137

*Regions and Divisions according to the U.S. Census Bureau
Source: Map courtesy of diymaps.net, public access. Data and map edition by author

Figure 1-5 Location of Research Parks in the U.S. by Region

The majority of North American RPs are located in the United States, with 137 RPs compared to the 21 RPs in Canada. Figure 1.5 shows detailed information about the distribution and percentage of the U.S. parks by region, according to the regions and divisions designed by the U.S. Census Bureau office. The states located in the South region are the most populated, with 55 RPs; this region accounts for the 40% of total U.S. research park's population. The Midwest and Western regions have about the same amount of RPs, with 34 and 31 RPs, respectively, and the least RPs populated region is in the Northeast with 17 research parks. The most populated division is the South Atlantic, with 35 RPs, and the least populated division is New England, with 6 RPs.

RP density per state is shown in Figure 1.6 below. The most populated state is Florida, with 10 RPs, six states have a high population density of 6-7 RPs, and seven states have a medium population density of 4-5 RPs. The majority of states, seventeen, have a low density of 2-3 RPs, and finally, thirteen states have only 1 research park, for a total of 137 RPs.

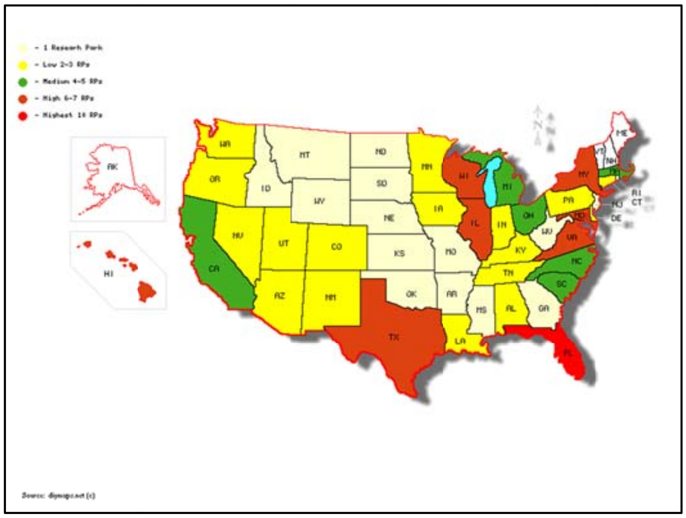


Figure 1-6 U.S. RPs Population Density by State

Sampling

Fowler (2014) provides a sampling method appropriate for this study that uses a combination of random and cluster sampling in a multistage sampling process. He uses one of the most generally useful multistage strategies for sampling a geographically defined population, dividing the target regions into exhaustive, mutually exclusive subregions with identifiable boundaries. These subregions are the clusters (Fowler, 2014, p.23) that take into consideration the percentage composition of the worldwide population in each continent, subcontinent, region and country, and within every region and division of the U.S. RP population. A fundamental factor used to evaluate a sampling method is the probability of selection of that percentage of the population that needs to be described, and the degree to which those excluded are distinctive (Fowler, 2014, p.17).

Data collection

The survey was distributed using the institutional web-based platform Purdue Qualtrics Survey Software. This method of data collection takes advantage of the e-mail use and basic computer skills, assumed to be present and active in the target population on a daily basis, that are needed to complete the self-administered online questionnaire, which contains closed statements to be answered mostly by clicking or checking a box.

No treatment of experiment was given to participants. Before the questionnaire was used with actual respondents, the survey instrument was pretested for concurrent validity to improve formatting and questions (Creswell, 2009, p.149).

Variables

For this study, the independent variables are geographical location, and ownership. The dependent variables evaluated in this study are the effectiveness as measured by the contribution of RPs in the economic growth and job creation. The efficiency, was measured by the interaction between the university and the research park; exclusively for university-based RPs; the characteristics of the innovation ecosystem and the culture of innovation.

Survey Results

The survey was distributed using the institutional web-based platform Purdue Qualtrics Survey Software; the survey was uploaded on January 24, 2015, for consideration and feedback of a panel of experts and it was released to participants on March 17, 2015. A total of 235 surveys were distributed worldwide, 42 e-mails were rejected. The last request to participate in the study was sent on May 20, 2015, answers were collected until June 15, 2015. A total of 130 surveys were collected for analysis, but 95 completed surveys were valid and coming from operating RPs, resulting in a response rate of 67.36%.

Data is presented using Table 1.6 to show the proportion of participants per continent, using number of surveys collected and percentages. The total sample size was 95 RPs equivalent to 11.98% of the added population of 793 RPs in these three continents, the largest sample proportion was from North American RPs with 16.46%, the smallest sample proportion was from Asian RPs with 10.26%, and the European sample was 11.22%, with 45 participant RPs out of 401 total in the continent.

Table 1-5 Sampling Proportion per Continent and Total

Continent	RPs Population	Participants	Percent
North America	158	26	16.46
Asia	234	24	10.26
Europe	401	45	11.22
TOTAL	793	95	11.98

The demographic data of participants, frequency and percentage are presented using Table 1.7. From the 95 respondents, 27.37% (*f* = 26) RPs are located in North America, 25.26% (*f* = 24) in Asia and 47.37% (*f* = 45) RPs are located in Europe.

Table 1-6 Geographical Location of Participants per Continent (N=95)

Continent	Frequency	Percent
North America	26	27.37
Asia	24	25.26
Europe	45	47.37
TOTAL	95	100.00

Table 1.8 shows the demographic data collected on the type of urban setting where the participating RPs are located. Of the 95 respondents, most of the participant RPs, 34.73% (*f* = 33) were located in an urban setting with a population of more than 1,000,000 people; 21.05% (*f* = 20) of participant RPs were located in urban areas having a population between 50,000 and 200,000; 18.95% (*f* = 18) of participant RPs were located in urban areas having a population between 200,001 and 500,000; 18.95% (*f* = 18) of participant RPs were located in urban areas having a population between 500,001 and 1,000,000 people; and finally 6.32% (*f* = 6) of participant RPs were located in the urban areas having a population of less than 50,000 people.

Table 1-7 Type of Urban Setting (N = 95)

Type of Urban Setting	Frequency	Percent
Population less than 50,000	06	6.32
50,000 to 200,000	20	21.05
200,001 to 500,000	18	18.95
500,001 to 1,000,000	18	18.95
More than 1,000,000 people	33	34.73
TOTAL	95	100.00

Table 1.9 shows the demographic data collected on the type of ownership for the RPs participating in the study, to differentiate university-based from non university-based research parks. Of the 95 RPs responding to this question, 63.16% (*f* = 60) participants were university-based RPs and 36.84% (*f* = 35) of participants were non university-based RPs.

Table 1-8 Ownership of Participant Research Parks (N=95)

Ownership	Frequency	Percent
University-based RPs	60	63.16
Non university-based RPs	35	36.84
TOTAL	95	100.00

Data Analysis

Items from returned surveys were analyzed using SPSS, a computerized statistical analysis software tool available at Purdue University. A descriptive statistical analysis was performed on items in section I, questions 1 through 5, to establish the demographic characteristics of the sample of participants across the regions. For sections II through V, using questions 6 to 25, to measure a total of 30 items; descriptive statistics are presented, including means and standard deviations of scores.

The average score differences were evaluated between the targeted continental regions; these scores were obtained through a Likert scale scoring system with values ranging from 1 (strongly disagree) through 5 (strongly agree) and a neutral position or neither disagree nor agree, with an assigned intermediate value of 3. The survey results allowed testing of the null hypothesis presented for this study using analysis of variance (ANOVA) instead of multiple t-tests, as more than two regions are being compared, and after checking data compliance with assumptions for normality, independency and equal variance (Howell, 2002).

A multivariate analysis of variance (MANOVA) was used to test for the interaction of the dependent variables, the effectiveness and the efficiency of Research Parks, to take into account the potential correlation of these two measures while testing for significance and to protect against Type I error if conducting multiple ANOVA tests independently. This helped to determine if significant differences exist that were not revealed when using the ANOVA test (Cooley & Lohnes, 1971).

The probability that the test statistic will take a value as extreme as the one obtained or the unlikeliness for this value to have occurred by chance, also known as *p*-value, was computed assuming that the null hypothesis in this study is true when they were tested for significance. Small *p*-values, lower than a pre-determined significance α level, ($p \leq \alpha$), which is usually set to range between 0.0 and 0.1 and most commonly $\alpha = 0.05$, will indicate strong evidence against the null hypothesis (Moore, McCabe & Craig, 2012).

Sample Characteristics

A Shapiro-Wilk's test ($p > 0.05$) (Shapiro & Wilk, 1965; Razali & Wah, 2011) and a visual inspection of their histograms, normal Q-Q plots and box plots showed that the scores for the dependent variable Effectiveness were approximately normally distributed for North American, Asian and European RPs, with a skewness of -0.788 (SE = 0.464) and a kurtosis of 0.122 (SE = 0.902) for North American RPs, a skewness of -0.080 (SE = 0.550) and a kurtosis of -0.345 (SE = 1.063) for Asian RPs and a skewness of -0.745 (SE = 0.383) and a kurtosis of -0.136 (SE = 0.750) for European RPs. The scores for the dependent variable Efficiency were also approximately normally distributed for North American, Asian and European RPs, with a skewness of -0.309 (SE = 0.464) and a kurtosis of 0.006 (SE = 0.902) for North American RPs, a skewness of -0.531 (SE = 0.564) and a kurtosis of -0.574 (SE = 1.091) for Asian RPs and a skewness of -0.462 (SE = 0.409) and a kurtosis of -0.609 (SE = 0.798) for European RPs. (Cramer, 1998; Cramer & Howitt, 2004; Doane & Seward, 2011). A Levene's test verified the equality of variances in the three samples ($p > 0.05$) (Martin & Bridgmon, 2012).

2. DATA ANALYSIS

This section presents the results of the Survey for Research, Science and Technology Parks (SRSTP). These results were analyzed to determine the differences in how managers and directors of RPs across the world evaluated their parks' effectiveness and efficiency. The effectiveness was measured by assessing the research park's contribution to economic growth and job creation in the region where it is located.

The efficiency of RPs was measured with respect to three general aspects: the first two regard the presence of basic characteristics of innovation and the degree of the culture of innovation within the ecosystem, and the third, exclusively for university-based RPs, addresses the interaction between the university and the research park.

Mean Data

The mean scores for each of the 19 questions, which contain the 30 items on the SRSTP, are shown in Table 4.1, with data presented in descending order. Answers were obtained based on a Likert-type scale to measure the participant's criteria related to the statements on the survey; scores range from one (strongly disagree) to five (strongly agree)

Table 2-1 Survey Results from all Research Parks

Item	Statement	Mean	SD
24	There is an important amount of technology-based Small and Medium Enterprises (SME) in the area	4.26	0.65
29	Tenants within the park are linked to businesses and organizations outside the park	4.01	0.54
20	The following local condition contributes to the continuous growth of this park: Living conditions	4.00	0.76
6	The park has increased the student's opportunities to get jobs	3.99	0.77
23	Intellectual Property Protection is in place to encourage entrepreneurship in the region.	3.99	0.67
12	University encourages faculty entrepreneurship	3.96	0.69
27	There are social informal activities to stimulate interaction among innovators and entrepreneurs	3.95	0.92
28	Local availability of applicable science and technology is the primary factor for innovation	3.92	0.66
8	The park has helped to improve the Visibility of the University	3.91	0.81
11	University facilitates faculty entrepreneurship	3.89	0.72
19	The following local condition contributes to the continuous growth of this park: Public services	3.77	0.69
25	There is a public anchor institution inside or close to the park working as a catalyst	3.75	0.83
7	The park has helped to improve the Quality of the University	3.73	0.80
22	The following local condition contributes to the continuous growth of this park: Primary and secondary education	3.69	0.84
2	The park is a magnet for scientists to universities in the area	3.68	0.99
16	Tenants in the park hire a large proportion of graduates from host U.	3.68	0.90
5	Tenants hire a large proportion of employees from local U. graduates	3.68	0.90
1	A relatively large proportion of the parks' professional workforce has been recruited from this area	3.66	1.03
26	There is a private anchor institution inside or close to the park working as a catalyst	3.64	0.81
30	Population in this area have a prevailing entrepreneurial culture	3.62	0.86
10	The park helps the university to generate private sponsor research	3.55	0.84
21	The following local condition contributes to the continuous growth of this park: Transportation system	3.53	0.94
17	Tenants in the park hire a large proportion of students from host U.	3.50	0.92
3	The park is a magnet for students to universities in the area	3.47	0.98
18	The easy access to venture capital help us creating start-ups	3.45	1.05
4	The park attracts sponsor research to local universities	3.44	0.85
13	The park has helped to attract Scientists to the University.	3.42	0.82
9	The park helps the university to generate public sponsor research	3.41	0.83
15	Tenants in the park hire a large proportion of scientists from host U.	3.32	0.94
14	The park has helped to increase enrollment of Students to the U.	3.22	0.80

The SRSTP question number 24, *There is an important amount of Technology-based Small and Medium Enterprises (SME) in the area,* had the highest mean (*M = 4.26, SD = 0.65*). The SRSTP question number 14, *The park has helped to increase enrollment of students to the University*, had the lowest mean (*M = 3.22, SD = 0.80*), when comparing scores on RPs from the three continents, North America, Asia and Europe.

Table 2.2 presents scores, in descending order, from directors of North American RPs; the SRSTP question number 12, *University encourages faculty entrepreneurship,* had the highest mean (*M = 4.08, SD = 0.64*). The SRSTP question number 18, *The easy access to venture capital help us creating start-ups*, had the lowest mean (*M = 3.08, SD = 1.14*), when comparing scores of participant RPs from North America.

Table 2.3 presents mean scores, in descending order, from RP directors' evaluation of participants from Asia; the SRSTP question number 24, *There is an important amount of technology-based Small and Medium Enterprises (SME) in the area,* had the highest mean (*M = 4.50, SD = 0.52*). The SRSTP question number 15, *Tenants in the park hire a large proportion of scientists from host University*, had the lowest mean (*M = 3.21, SD = 1.12*), when comparing scores of participant Asian RPs.

Table 2.4 presents mean scores, in descending order, from RP directors evaluating European RPs only; the SRSTP question number 24, *There is an important amount of technology-based Small and Medium Enterprises (SME) in the area,* had the highest mean (*M = 4.38, SD = 0.61*). The SRSTP question number 14, *The park has helped to increase enrollment of Students to the University*, had the lowest mean (*M = 3.09, SD = 0.79*), when comparing scores of participant RPs from Europe.

Table 2-2 Survey Results from North American Research Parks

Item	Statement	Mean	SD
12	University encourages faculty entrepreneurship	4.08	0.64
23	Intellectual Property Protection is in place to encourage entrepreneurship in the region.	4.04	0.73
24	There is an important amount of technology-based Small and Medium Enterprises (SME) in the area	3.96	0.68
8	The park has helped to improve the Visibility of the University	3.96	0.95
29	Tenants within the park are linked to businesses and organizations outside the park	3.92	0.58
20	The following local condition contributes to the continuous growth of this park: Living conditions	3.88	0.83
6	The park has increased the student's opportunities to get jobs	3.88	0.88
28	Local availability of applicable science and technology is the primary factor for innovation	3.88	0.54
25	There is a public anchor institution inside or close to the park working as a catalyst	3.88	0.85
11	University facilitates faculty entrepreneurship	3.87	0.81
16	Tenants in the park hire a large proportion of graduates from host U.	3.83	0.76
7	The park has helped to improve the Quality of the University	3.79	0.88

5	Tenants hire a large proportion of employees from local U. graduates	3.76	0.88
27	There are social informal activities to stimulate interaction among innovators and entrepreneurs	3.72	1.06
15	Tenants in the park hire a large proportion of scientists from host U.	3.71	0.75
19	The following local condition contributes to the continuous growth of this park: Public services	3.64	0.57
26	There is a private anchor institution inside or close to the park working as a catalyst	3.60	0.91
22	The following local condition contributes to the continuous growth of this park: Primary and secondary education	3.60	0.87
10	The park helps the university to generate private sponsor research	3.52	0.82
4	The park attracts sponsor research to local universities	3.52	0.77
1	A relatively large proportion of the parks' professional workforce has been recruited from this area	3.52	0.96
17	Tenants in the park hire a large proportion of students from host U.	3.52	0.77
2	The park is a magnet for scientists to universities in the area	3.50	0.93
13	The park has helped to attract Scientists to the University.	3.46	0.78
30	Population in this area have a prevailing entrepreneurial culture	3.46	0.83
21	The following local condition contributes to the continuous growth of this park: Transportation system	3.36	0.86
9	The park helps the university to generate public sponsor research	3.33	0.70
3	The park is a magnet for students to universities in the area	3.17	0.96
14	The park has helped to increase enrollment of Students to the U.	3.12	0.78
18	The easy access to venture capital help us creating start-ups	3.08	1.14

Table 2-3 Survey Results from Asian Research Parks

Item	Statement	Mean	SD
24	There is an important amount of technology-based Small and Medium Enterprises (SME) in the area	4.50	0.52
6	The park has increased the student's opportunities to get jobs	4.35	0.61
3	The park is a magnet for students to universities in the area	4.20	0.68
19	The following local condition contributes to the continuous growth of this park: Public services	4.13	0.72
23	Intellectual Property Protection is in place to encourage entrepreneurship in the region.	4.06	0.57
2	The park is a magnet for scientists to universities in the area	4.06	0.90
1	A relatively large proportion of the parks' professional workforce has been recruited from this area	4.06	0.83
20	The following local condition contributes to the continuous growth of this park: Living conditions	4.00	0.63
11	University facilitates faculty entrepreneurship	3.93	0.59
29	Tenants within the park are linked to businesses and organizations outside the park	3.88	0.62
22	The following local condition contributes to the continuous growth of this park: Primary and secondary education	3.81	0.83
21	The following local condition contributes to the continuous growth of this park: Transportation system	3.81	0.91

28	Local availability of applicable science and technology is the primary factor for innovation	3.81	0.66
27	There are social informal activities to stimulate interaction among innovators and entrepreneurs	3.81	0.98
12	University encourages faculty entrepreneurship	3.80	0.68
13	The park has helped to attract Scientists to the University.	3.80	0.77
18	The easy access to venture capital help us creating start-ups	3.75	1.00
26	There is a private anchor institution inside or close to the park working as a catalyst	3.73	0.96
16	Tenants in the park hire a large proportion of graduates from host U.	3.71	1.14
5	Tenants hire a large proportion of employees from local U. graduates	3.71	0.77
8	The park has helped to improve the Visibility of the University	3.69	0.48
7	The park has helped to improve the Quality of the University	3.69	0.48
30	Population in this area have a prevailing entrepreneurial culture	3.69	0.70
14	The park has helped to increase enrollment of Students to the U.	3.67	0.72
25	There is a public anchor institution inside or close to the park working as a catalyst	3.63	0.89
17	Tenants in the park hire a large proportion of students from host U.	3.50	1.22
10	The park helps the university to generate private sponsor research	3.50	0.89
9	The park helps the university to generate public sponsor research	3.31	0.95
4	The park attracts sponsor research to local universities	3.24	1.03
15	Tenants in the park hire a large proportion of scientists from host U.	3.21	1.12

Table 2-4 Survey Results from European Research Parks

Item	Statement	Mean	SD
24	There is an important amount of technology-based Small and Medium Enterprises (SME) in the area	4.38	0.61
27	There are social informal activities to stimulate interaction among innovators and entrepreneurs	4.18	0.73
29	Tenants within the park are linked to businesses and organizations outside the park	4.15	0.44
20	The following local condition contributes to the continuous growth of this park: Living conditions	4.09	0.77
28	Local availability of applicable science and technology is the primary factor for innovation	4.00	0.75
8	The park has helped to improve the Visibility of the University	3.97	0.83
12	University encourages faculty entrepreneurship	3.94	0.74
23	Intellectual Property Protection is in place to encourage entrepreneurship in the region.	3.91	0.68
6	The park has increased the student's opportunities to get jobs	3.89	0.73
11	University facilitates faculty entrepreneurship	3.88	0.73
25	There is a public anchor institution inside or close to the park working as a catalyst	3.73	0.80
30	Population in this area have a prevailing entrepreneurial culture	3.70	0.95
22	The following local condition contributes to the continuous growth of this park: Primary and secondary education	3.70	0.85
7	The park has helped to improve the Quality of the University	3.70	0.88

19	The following local condition contributes to the continuous growth of this park: Public services	3.70	0.73
2	The park is a magnet for scientists to universities in the area	3.63	1.05
26	There is a private anchor institution inside or close to the park working as a catalyst	3.63	0.66
5	Tenants hire a large proportion of employees from local U. graduates	3.61	0.97
10	The park helps the university to generate private sponsor research	3.59	0.86
1	A relatively large proportion of the parks' professional workforce has been recruited from this area	3.58	1.13
18	The easy access to venture capital help us creating start-ups	3.58	0.97
16	Tenants in the park hire a large proportion of graduates from host U.	3.56	0.89
21	The following local condition contributes to the continuous growth of this park: Transportation system	3.53	1.02
9	The park helps the university to generate public sponsor research	3.50	0.86
17	Tenants in the park hire a large proportion of students from host U.	3.48	0.91
4	The park attracts sponsor research to local universities	3.47	0.83
3	The park is a magnet for students to universities in the area	3.37	0.97
13	The park has helped to attract Scientists to the University.	3.24	0.82
15	Tenants in the park hire a large proportion of scientists from host U.	3.09	0.91
14	The park has helped to increase enrollment of Students to the U.	3.09	0.79

Survey Validity and Reliability

Internal consistency reliability estimates a group of items in a survey that are considered to be measuring different aspects of the same construct (Litwin, 1995); the items on the Survey for Research, Science and Technology Parks measures a total of four different parts: the effectiveness, which was measured by assessing one general aspect: the research park’s contribution to economic growth and job creation in the region; and the Efficiency of RPs, which measured with respect to three aspects: the first two regard the presence of basic characteristics of innovation and the degree of the culture of innovation within the ecosystem, and the third, exclusively for university-based RPs, addresses the interaction between the university and the research park.

Cronbach's Coefficient Alpha, which provides a unique estimate (Cronbach, 1951), was used to measure the internal consistency for the reliability of the survey instrument. For the items on the SRSTP, Cronbach's Coefficient Alpha was $\alpha = 0.865$.

Null Hypothesis One

Ho_1: There is no significant difference in the evaluation of best practices regarding effectiveness, as measured by the contribution to the economic growth and job creation, between Asian, European and North American research parks.

Table 2.5 provides the mean scores for items one through six, which assessed the effectiveness of RPs as measured by their contribution to economic growth and job creation within the region. The table presents the means for RP directors from Asia, Europe and North America. For the three groups, the SRSTP item number six, *The park has increased the student's opportunities to get jobs,* had the highest mean.

The lowest mean scores were different among the three samples. For North American RPs, it was SRSTP item number three, *The park is a magnet for students to universities in the area*; for Asian RPs, SRSTP item number four, *The park attracts sponsor research to local universities;* and for European RPs, SRSTP item number three, *The park is a magnet for students to universities in the area,* which had the lowest mean score in each sample.

Table 2.6 presents a one-way ANOVA comparing directors' evaluation of RPs from North America, Asia and Europe on the effectiveness, measured as the RPs' contribution to the economic growth and job creation within the region, at the level $p < 0.05$ [$F = 2.336$, $p = 0.104$]. Therefore, not enough evidence is available to reject null hypothesis one.

Table 2-5 Survey Results on Contribution to Economic Growth and Job Creation

No.	Statement	N.AMERICA		ASIA		EUROPE	
		M	SD	M	SD	M	SD
1	A relatively large proportion of the parks' professional workforce has been recruited from this area	3.52	0.96	4.06	0.83	3.58	1.13
2	The park is a magnet for scientists to universities in the area	3.50	0.93	4.06	0.90	3.63	1.05
3	The park is a magnet for students to universities in the area	3.17	0.96	4.20	0.68	3.37	0.97
4	The park attracts sponsor research to local universities	3.52	0.77	3.24	1.03	3.47	0.83
5	Tenants hire a large proportion of employees from local University graduates	3.76	0.88	3.71	0.77	3.61	0.97
6	The park has increased the student's opportunities to get jobs	3.88	0.88	4.35	0.61	3.89	0.73

Note: Scores in a five-points scale: (1) strongly disagree to (5) strongly agree

Table 2-6 Summary of ANOVA Comparing Location with Contribution to Economic Growth and Job Creation

Source	Sum of Squares	df	Mean Square	F	Sig.*
Between Groups	1.537	2	0.768	2.336	0.104
Within Groups	24.013	73	0.329		
Total	25.550	75			

*Significance level at $p < 0.05$

Null Hypothesis Two

Ho_2: There is no significant difference in the evaluation of best practices regarding efficiency, as measured by the interaction: “university-research park”, between Asian, European and North American university-based research parks.

Table 2.7 provides the mean scores for items seven through seventeen, regarding the efficiency of research "university-research park." The table presents the mean scores from directors of participant RPs from Asia, Europe and North America. For the North American sample, SRSTP item number twelve, *University encourages faculty entrepreneurship,* had the highest mean; while for Asian participants, SRSTP item number eleven, *University facilitates faculty entrepreneurship,* and for European participants, SRSTP item number eight, *The park has helped to improve the Visibility of the University,* had the highest means.

The lowest mean scores for North American and European RPs was SRSTP item number three, *The park is a magnet for students to universities in the area;* for Asian RPs, it was SRSTP item number fifteen, *Tenants in the park hire a large proportion of scientists from host University*.

Table 2.8 presents a one-way ANOVA comparing directors’ scores of RPs from North America, Asia and Europe on the efficiency in the interaction University - Research Park, at the level $p < 0.05$ [$F = 0.373$, $p = 0.690$]. Therefore, failing to reject null hypothesis two.

Table 2-7 Survey Results on Interaction University - Research Park

No.	Statement	N.AMERICA		ASIA		EUROPE	
		M	SD	M	SD	M	SD
7	The park has helped to improve the Quality of the University	3.79	0.88	3.69	0.48	3.70	0.88
8	The park has helped to improve the Visibility of the University	3.96	0.95	3.69	0.48	3.97	0.83
9	The park helps the university to generate public sponsor research	3.33	0.70	3.31	0.95	3.50	0.86
10	The park helps the university to generate private sponsor research	3.52	0.82	3.50	0.89	3.59	0.86
11	University facilitates faculty entrepreneurship	3.87	0.81	3.93	0.59	3.88	0.73
12	University encourages faculty entrepreneurship	4.08	0.64	3.80	0.68	3.94	0.74
13	The park has helped to attract Scientists to the University.	3.46	0.78	3.80	0.77	3.24	0.82
14	The park has helped to increase enrollment of Students to the U.	3.12	0.78	3.67	0.72	3.09	0.79
15	Tenants in the park hire a large proportion of scientists from host U.	3.71	0.75	3.21	1.12	3.09	0.91
16	Tenants in the park hire a large proportion of graduates from host U.	3.83	0.76	3.71	1.14	3.56	0.89
17	Tenants in the park hire a large proportion of students from host U.	3.52	0.77	3.50	1.22	3.48	0.91

Note: Scores in a five-points scale: (1) strongly disagree to (5) strongly agree

Table 2-8 Summary of ANOVA Comparing Location with Interaction University - Research Park

Source	Sum of Squares	df	Mean Square	F	Sig.*
Between Groups	0.209	2	0.105	0.373	0.690
Within Groups	17.932	64	0.280		
Total	18.141	66			

*Significance level at $p < 0.05$

Null Hypothesis Three

Ho_3: There is no significant difference in the evaluation of best practices regarding efficiency, as measured by the characteristics of the innovation ecosystem, between Asian, European and North American research parks.

Table 2.9 provides the mean scores for items eighteen through twenty six, regarding the efficiency as measured by the characteristics of the innovation ecosystem. The table presents the means for directors' evaluation of RPs from Asia, Europe and North America. For the North American sample, SRSTP item number twenty three, *Intellectual Property Protection is in place to encourage entrepreneurship in the region,* had the highest mean; while for Asian and European participants, SRSTP item number twenty four, *There is an important amount of technology-based Small and Medium Enterprises (SME),* had the highest means.

The lowest mean scores were different among the three samples. For North American RPs, it was SRSTP item number eighteen, *The easy access to venture capital help us creating start-ups*; for Asian RPs, SRSTP item number twenty five, *There is a public anchor institution inside or close to the park working as a catalyst;* and for European RPs, SRSTP item number twenty one, *The following local condition contributes to the continuous growth of this park: Transportation system,* which had the lowest mean score in each sample.

Table 2-9 Survey Results on Characteristics of the Innovation Ecosystem

No.	Statement	N.AMERICA		ASIA		EUROPE	
		M	SD	M	SD	M	SD
18	The easy access to venture capital help us creating start-ups	3.08	1.14	3.75	1.00	3.58	0.97
19	The following local condition contributes to the continuous growth of this park: Public services	3.64	0.57	4.13	0.72	3.70	0.73
20	The following local condition contributes to the continuous growth of this park: Living conditions	3.88	0.83	4.00	0.63	4.09	0.77
21	The following local condition contributes to the continuous growth of this park: Transportation system	3.36	0.86	3.81	0.91	3.53	1.02
22	The following local condition contributes to the continuous growth of this park: Primary and secondary education	3.60	0.87	3.81	0.83	3.70	0.85

23	Intellectual Property Protection is in place to encourage entrepreneurship in the region.	4.04	0.73	4.06	0.57	3.91	0.68
24	There is an important amount of technology-based Small and Medium Enterprises (SME) in the area	3.96	0.68	4.50	0.52	4.38	0.61
25	There is a public anchor institution inside or close to the park working as a catalyst	3.88	0.85	3.63	0.89	3.73	0.80
26	There is a private anchor institution inside or close to the park working as a catalyst	3.60	0.91	3.73	0.96	3.63	0.66

Note: Scores in a five-points scale: (1) strongly disagree to (5) strongly agree

Table 2.10 presents a one-way ANOVA comparing directors' scores of RPs from North America, Asia and Europe, in how they evaluate efficiency, as measured by the characteristics of the innovation ecosystem, at the level $p < 0.05$ [$F = 1.429$, $p = 0.247$]. Therefore, not enough evidence is available to reject null hypothesis three.

Table 2-10 Summary of ANOVA Comparing Location with the Characteristics of the Innovation Ecosystem

Source	Sum of Squares	df	Mean Square	F	Sig.*
Between Groups	0.635	2	0.317	1.429	0.247
Within Groups	14.439	65	0.222		
Total	15.074	67			

*Significance level at $p < 0.05$

Null Hypothesis Four

Ho_4: There is no significant difference in the evaluation of best practices regarding efficiency, as measured by the culture of innovation in the ecosystem, between Asian, European and North American research parks.

Table 2.11 provides the mean scores for items twenty seven through thirty, regarding efficiency as measured by the culture of innovation in the ecosystem. The table presents the mean scores from directors of participant RPs from Asia, Europe and North America. For the North American and Asian samples, SRSTP item number twenty nine, *Tenants within the park are linked to businesses and organizations outside the park,* had the highest means; while for European participants, SRSTP item number twenty seven, *There are social informal activities to stimulate interaction among innovators and entrepreneurs,* had the highest mean.

The lowest mean scores were the same for North American, Asian and European RPs: it was SRSTP item number thirty, *Population in this area have a prevailing entrepreneurial culture.*

Table 2-11 Survey Results on the Culture of Innovation

No.	Statement	N.AMERICA		ASIA		EUROPE	
		M	SD	M	SD	M	SD
27	There are social informal activities to stimulate interaction among innovators and entrepreneurs	3.72	1.06	3.81	0.98	4.18	0.73
28	Local availability of applicable science and technology is the primary factor for innovation	3.88	0.54	3.81	0.66	4.00	0.75
29	Tenants within the park are linked to businesses and organizations outside the park	3.92	0.58	3.88	0.62	4.15	0.44
30	Population in this area have a prevailing entrepreneurial culture	3.46	0.83	3.69	0.70	3.70	0.95

Note: Scores in a five-points scale: (1) strongly disagree to (5) strongly agree

Table 2.12 presents a one-way ANOVA comparing directors' scores of RPs from North America, Asia and Europe on efficiency as measured by the culture of innovation in the ecosystem, at the level $p < 0.05$ [$F = 1.840$, $p = 0.167$]. Therefore, not enough evidence is available to reject null hypothesis four.

Table 2-12 Summary of ANOVA Comparing Location with the Culture of Innovation

Source	Sum of Squares	df	Mean Square	F	Sig.*
Between Groups	0.897	2	0.449	1.840	0.167
Within Groups	16.577	68	0.244		
Total	17.474	70			

*Significance level at p < 0.05

Further analysis was conducted using a MANOVA to test for the interaction of the dependent variables: Effectiveness and Efficiency. Table 2.13 presents the results of the Multivariate Tests and Table 2.14 presents the results of a MANOVA comparing directors' scores of RPs from North America, Asia and Europe on the interaction of efficiency and effectiveness; there were no significant differences between the groups at the level $p < 0.05$.

Table 2-13 Results of the Multivariate Tests

Effect		Value	F	Hyp. df	Error df	Sig*.
CONTINENT	Pillai's Trace	0.083	1.233	4.000	114.000	0.301
	Wilks' Lambda	0.917	1.238	4.000	112.000	0.299
	Hotelling's Trace	0.090	1.241	4.000	110.000	0.298
	Roy's Largest Root	0.089	2.548	2.000	57.000	0.087

*Significance level at p < 0.05

Table 2-14 Summary of MANOVA test for the interaction of Effectiveness and Efficiency

Source	Dependent Variable	Sum of Squares	df	Mean Square	F	Sig.*
Corrected Model	Effectiveness	1.869	2	0.935	2.547	0.087
	Efficiency	0.206	2	0.103	0.690	0.506
CONTINENT	Effectiveness	1.869	2	0.935	2.547	0.087
	Efficiency	0.206	2	0.103	0.690	0.506
Error	Effectiveness	20.918	57	0.367		
	Efficiency	8.503	57	0.149		
Total	Effectiveness	817.278	60			
	Efficiency	839.385	60			
Corrected Total	Effectiveness	22.787	59			
	Efficiency	8.709	59			

*Significance level at $p < 0.05$

3. Discussion

Section 3 presents a general overview of the study, the most relevant findings from the analysis of the data collected, and also a discussion of these findings. The conclusions, recommendations and questions for further research are provided at the end of the section.

The Survey for Research, Science and Technology Parks, an online questionnaire with 29 items, was used to collect data with samples from the three continents and compared them in order to test each of the four hypotheses using a one-way ANOVA, before deciding, based on the p-value established at the $p < 0.05$ level of significance, to retain or reject the null hypothesis. 130 surveys were returned for a response rate of 67.36%.

Major Findings

The answers from the SRSTP were used to determine if there was a significant difference in what administrators of RPs from Asia, Europe and North America (independent variable) view as best practices regarding the effectiveness of RPs, measured by the contribution to the economic growth and job creation; and the efficiency of RPs, measured by the interaction "university-research park," the characteristics of the innovation ecosystem, and the culture of innovation (dependent variables). Results from Section 2 generated the following major findings:

1. There was no significant difference in the RPs directors' evaluation of best practices regarding effectiveness, as measured by the contribution to the economic growth and job creation, between Asian, European and North American research parks, $p < 0.05$ [$F = 2.336$, $p = 0.104$].
2. There was no significant difference in the RPs directors' evaluation of best practices regarding efficiency, as measured by the interaction: “university-research park”, between Asian, European and North American university-based research parks, $p < 0.05$ [$F = 0.373$, $p = 0.690$].

3. There was no significant difference when comparing the RPs directors' evaluation of best practices regarding efficiency, as measured by the characteristics of the innovation ecosystem, between Asian, European and North American research parks, $p < 0.05$ [$F = 1.429$, $p = 0.247$].
4. There was no significant difference when comparing the RPs directors' evaluation of best practices regarding efficiency, as measured by the culture of innovation in the ecosystem, between Asian, European and North American research parks, $p < 0.05$ [$F = 1.840$, $p = 0.167$].
5. No significant differences were found when MANOVA treatments were conducted to analyze the different responses based upon continent: Asia, Europe and North America, and the interaction between the dependent variables: Effectiveness and Efficiency.

Discussion

This study shows a general agreement between Asian, European and North American RPs directors' evaluation regarding best practices, which are described through the 29 items arranged in the SRSTP in four areas: the RPs' effectiveness, measured by their contribution to economic growth and job creation; their efficiency, measured by the basic characteristics present within the innovation ecosystem; the culture of innovation distinctive in the area where the parks are located; and, for those university-based RPs, the interactions between the university and the research park.

Results from the study show that RPs are effective as a work source for skilled labor force, providing job opportunities, employing university students, and recruiting a large proportion of the park's professional workforce from the area; this seems a natural consequence of locating an RP within the ecosystem, and it was a common characteristic typically found in each of the three continents, supporting the findings of Goldstein and Luger (1991), Shearmur and Doloreux (2000), Link & Scott (2006) and also in agreement with the results of Bianchi & Labory (2008).

One of the byproducts from this study is the priority participants give to the different components in their own innovation ecosystem; they agreed on what major features should be present, but the importance of each component in the correspondent ecosystem varies according to the perceptions of participant RPs among the three continents. Minor differences were shown in the RP director’s criteria regarding the role RPs play when attracting new students and research funds to the ecosystem. While North American and European participants believe RPs do not help in attracting new students to universities located in the area, Asian participants believe that they do influence new students’ decision to come to neighboring universities. For North American participants, RPs increase the flow of research funds to universities, but Asian and European participants do not think RPs help attract sponsor research to local universities.

North American RP directors believe that having a legal framework in place, such as intellectual property protection law and its enforcement, is important to encourage entrepreneurship. They also believe that the presence of a significant amount of technology-based SMEs, a public anchor institution working as a catalyst in the region, and good living conditions are important factors for nurturing a healthy innovation ecosystem.

Asian and European ecosystem characteristics, while not much different than those in U.S. and Canada, do have more in common with each other than those in North America; participants from the former continents agree that important factors helping to nurture the RPs' growth are a good amount of SMEs in the area and the quality of public services and good living conditions; they rank these higher in importance than intellectual property protection, which more North American participants supported. This is in agreement with the findings of Bosworth and Yang (2000). According to the Asian participants, public anchor institutions serving as catalysts for economic growth are not as common in their ecosystems as they are in North America.

Regarding how the interaction between universities and research parks promotes scientific innovation, all directors of North American, Asian and European university-based RPs' responded that universities encourage and facilitate faculty members to become entrepreneurs; this is in agreement with Jensen and Thursby (2001), who pointed out that scientists' involvement in the process increases the probability that they will succeed in commercializing their inventions.

North American and European participants agreed that the research park helps to promote the visibility of the university with which parks are affiliated, but RPs do not influence the quality of the university. For Asian participants, RPs help to attract scientists to the university but they are not hired by tenants of the RP; also, the parks do influence the enrollment of students in the University; this agrees with the experience of RPs from Asia, where students see the park as a potential work source when deciding to go to neighboring universities. On the contrary, for European and North American RPs' directors, the park does not influence the enrollment of students in the host university.

Regarding the statement that "Tenants in the park hire a large proportion of scientists from host University" this is more the case for North American RPs than for European and Asian participants, where there are more job opportunities for university graduates than for university scientists.

When analyzing the second of the three dimensions proposed to assess the efficiency of a research park, the characteristics of the innovation ecosystem, it is notable that for Asian and European participants the most important characteristic of an innovation ecosystem should be a significant amount of technology-based small and medium enterprises (SMEs), while North Americans believe intellectual property protection regulations should be prioritized in order to encourage entrepreneurship in the region and supported by a significant number of SMEs in the area, which is in agreement with Tran, Daim & Kocaoglu, (2011).

The three groups surveyed differed on which characteristics need to be improved to nurture a healthy environment of innovation. , Europeans believe it is the transportation system, Asians think it is public and private anchor institutions, and North Americans want more availability of venture capital to helps create more start-ups, which in agreement with the barriers pointed by Kirkland (1999).

Finally, the last dimension that measured the RPs' efficiency is the culture of the innovation ecosystem. In this aspect North American and Asian participants agree that the most important factor in boosting innovation is that tenant companies residing inside the park have close ties with organizations and business networks from outside of the park, followed by the availability of applicable science and technology.

European participants believe that the informal interaction between innovators and entrepreneurs through social activities is more important to stimulate the ecosystem outcomes than the tenant's relationships with outside companies. All participants agreed that the entrepreneurial culture of the population is the least important compared to the other three characteristics presented as part of the ecosystem: Social informal activities among innovators and entrepreneurs, local availability of applicable science and technology and the relationships of tenants with organizations outside the park.

Conclusions

The following conclusions have been obtained under the assumptions, delimitations and limitations framing this study:

1. There are no differences between North American, Asian and European RPs' director's evaluation of the effectiveness of RPs as measured by contribution to economic growth and job creation; and in the efficiency, measured by the interaction university-research park, the characteristics of the innovation ecosystem, and the culture of innovation. Therefore, the four null hypotheses were retained.
2. Considering all participants' combined criteria ranking them in order of importance, the factors that most influence RPs' effectiveness and efficiency are: an important number of technology-based SMEs in the area; a close relationship between tenants in the park and businesses and organizations outside the park; good living conditions; students' opportunities for employment; and intellectual property regulations and protection in place.

Recommendations

As a corollary from this study, it is important to frame the RPs within the ecosystem and to put the research park initiative in context as a recommendation for new or existing project developers. RPs are an important element in technological innovation, but they cannot work in isolation, as they are one part of a more complex system. In this system all components fulfill a specific role and interact with each other to create the dynamic forces needed for a successful innovation ecosystem. New supporters of technological innovation as a strategy to stimulate economic growth must consider that components are needed beyond investments in technological infrastructure; all these components are irreplaceable, must co-exist, and should be planned and developed simultaneously.

The cornerstone supporting the innovation ecosystem is people; without the scientists and researchers' creation of suitable technologies the innovation process could not begin. Technological infrastructure is another component, as scientists need laboratories where they can work, experiment and train future scientists. Also irreplaceable are government grants for basic research, because the results of research are not immediately evident; basic research takes a great deal of effort, patience, constancy, and even a dose of serendipity until tangible results can be seen, making it unattractive for private sector involvement.

In addition to providing research funds to the university system as well as to national laboratories, the government also furnishes an adequate and reliable legal framework to entice and promote private sector participation. This provides an environment that not only guarantees but also incentivizes; for example, through tax holidays; private industry involvement. Risk is always implicit in these kinds of investments due to the uncertainties; therefore, they require an environment with a trustworthy legal system and regulatory organizations within the ecosystem.

Universities and national laboratories have proven to be appropriate drivers of technology. Their role in the ecosystem is to compete for and to channel public financial resources and to turn them into intellectual property. Royalties and shares produced with the commercialization of these technologies to private companies generate more economic revenues that go back to sustain the research endeavors. These private companies, interested in the potential applications of these discoveries, buy the patents and invest through in-house research to further develop the invention until a marketable product is attained; alternatively, they, sponsor the applied research with the same university in exchange for equity.

When the chances of economic return and potential application of the new technology are promising, the university, with the involvement of the inventor or scientists, continues funding the research through the development of the product, by using its own resources and encouraging and facilitating their teachers and scientists to become entrepreneurs.

In the product development stage the government investment typically decreases or disappears and the private sector finances the costs of research for product development. This financial transition, commonly known as the "valley of death," is the turning point where discoveries either receive an injection of private fresh capital to pay the additional research needed until the successful development of the new product, or remain just another invention disclosure without a proven practical application.

Universities are an important part of the innovation ecosystem because they create knowledge, which drives economic growth. In competitive higher education system; universities, besides competing for government research funds towards basic and applied research, build a scientific base and produce knowledge—this is the first step in the innovation process. The most prestigious universities are like giant magnets attracting the best talent around the world and the best faculty to serve as mentors.

Through scientists' work with the most promising students to transfer explicit and tacit knowledge, and through experimenting in their laboratories and testing new ideas, universities become crossroads where ideas converge. Along with building the knowledge and scientific base, universities prepare the future scientists in the ecosystem. There is a permanent competitive race between universities to attract the most qualified human talent, faculty, researchers and students.

RPs are the showcase for applied technologies, and as such are responsible for marketing the university's intellectual property to private businesses or to create start-ups. These are usually located within the park to take advantage of the proximity to faculty, students, laboratories, and amenities, assisting start-ups to financially grow. Here the start-ups, take advantage of the business networks and links formed with companies outside of the park to commercialize new products, capture resources from capital markets, venture capitalists or angel investors, and fund the development of the new products.

The atmosphere surrounding the park and neighboring universities should be attractive in order to appeal to the scientists and students who choose to live in this ecosystem. It is desirable for the RP to be in safe area, with optimal living conditions, school systems with world-class education, public transportation systems, and general services that will provide a high quality of living.

To increase the critical mass of human talent and shape future scientists, the K-12 and higher education system should be academically strong and aim for international standards, with the goal of providing students the basic tools in key areas like STEM education to prepare them as potential scientists.

The constant stream of innovative products promotes the presence of many technology-based small and medium enterprises, creating demand for the technologies developed at the university and offering jobs to university students and graduates. These companies become catalysts for economic growth and job creation in the region.

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