Value Added Contributions of Science Parks—the Case of the Barcelona Scientific Park

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ABSTRACT
Science parks are institutions that support the creation and development of high technology-based companies. They are designed to provide value-added services together with high-quality space and facilities and to promote interaction amongst universities, R&D institutions, companies, and markets. Although Spain is among the countries that have been investing heavily in these institutions, there is lack of feedback from the tenant companies' perspective with respect to the value added that they receive from science parks. The objective of this study is to evaluate the services that the Barcelona Science Park offers to its tenants by gathering information from the companies currently located in the park and those that have graduated. By comparing the results obtained from the two groups of companies, incubated and graduated, we examine whether the opinions differ about their appreciation of the services that they benefited from during their stay in the Park than those currently remaining.

1. INTRODUCTION

In recent years, a growing trend has emerged in relation to the establishment and development of companies with high added-value knowledge. Entrepreneurs have realised how important the development of research and innovation is in the process of creating new companies characterised by small size. Technology-based firms often benefit from the support received from projects carried out in universities and specialised centres with highly qualified human resources and substantial investments in research infrastructure. In particular, science parks have been created with the objective of providing resources that help to satisfy some of the needs of these companies. Science parks facilitate the creation and development of these firms with high levels of expertise, providing a physical space within an environment that helps and encourages research and innovation and also offers support through attractive incentives, incubator programs, and so on. In this context, science parks generally make life easier for tenant companies.

The innovative capacity of a system, either national or regional, depends not only on its quantitative effort in Research and Development (R&D), both expenditure and personnel, and its technological infrastructure; but also on the generation of externalities through interaction among the various actors of the system, such as those in business or government [1].

Some published Spanish studies characterise the companies that collaborate with technology centres [2]. Other studies examine public policy training and the research potential of human capital or analyse the science and technology parks by describing their evolution and/or comparing different parks in different countries [3]. Another noteworthy method focuses on regional studies on innovation and discusses the advantages and disadvantages of science and technology parks in a region or country [4]. Obviously, the literature dedicated to the field of entrepreneurship is also relevant.

Factors that affect the performance of technology-based firms are not only of a technological nature. There are also non-technological factors, such as the characteristics of the entrepreneur, the field of activity of the business, variables related to financing or the internal organisation of the company, the human resources aspect, and variables related to the science park [5]. However, which of these factors is the most influential? Is there a relation between these factors? How can we measure the impact of each variable? We believe that by finding answers to these questions we can then categorise the problems that new technology-based firms face. Basically, we will attempt to apply the "divide and conquer"[1] strategy in relation to the types of services offered by science parks. Although this

[1]Derived from the Latin, *divide et impera* is a combination of political, military and economic strategies of gaining and maintaining power by breaking up larger concentrations of power into chunks that individually have less power than the one implementing the strategy.

phenomenon is highly promoted in Spain, there is lack of feedback from the tenant companies' perspective with respect to the value added they receive from science parks.

The first objective of this study is to design a questionnaire intended to represent a tool for the assessment of the science park's services based on the evaluation of presently incubated and graduated companies. The evaluation will be subject to two perspectives: the basic business support services provided, and the social networks, which we shall refer to as social support services. This paper is intended to enrich the Spanish literature on the evaluation of science parks by conducting the second aim of this study, which is to identify the services of a science park that add greater value to *start-ups* and other businesses that are hosted therein, and in this way, anticipate future problems that the companies located therein can expect to experience. An empirical analysis of companies in the Barcelona Science Park is presented.

2. LITERATURE REVIEW AND THEORETICAL FRAMEWORK

The aims stated most often for a science park are to foster innovation by linking basic research to industrial policy and to support economic growth though job creation. Bearing these aims in mind, a science park creates the technical, logistical, and administrative support infrastructure that new firms require to survive during the growth process [6]. No unanimously accepted definition of a science park exists, and it is therefore important to briefly review the most frequently used and widely known definitions.

According to the International Association of Science Parks (IASP) [7], a science park is "an organization managed by specialized professionals, whose main aim is to increase the wealth of its community by promoting the culture of innovation and the competitiveness of its associated businesses and knowledge-based institutions." To enable these goals to be met, a Science Park has to "stimulate and manage the flow of knowledge and technology amongst universities, R&D institutions, companies and markets; facilitate the creation and growth of innovation-based companies through incubation and spin-off processes; and provide other value-added services together with high quality space and facilities."

Taking this definition into account, a science and technology park is a project, usually associated with a physical space, which has the following characteristics:

- Maintains formal and operational dealings with universities, research centres and higher educational institutions;
- Is designed to encourage the creation and growth of knowledge-based companies and other organisations belonging to the service sector, which are normally established in the park itself, with a high added value;
- Is directed by a stable managing body that promotes the transfer of technology and fosters innovation between the companies and organisations that use the park.

With the passage of time, the evaluation of science parks and university incubators has engaged the interest of several investigators. Some studies have compared firms located inside and outside of science parks to determine which performed better [8,9,10,11,12]; others have aimed at developing an evaluation framework for university incubators [6,13,14[2],15,16,17]. The empirical literature does not always agree that science parks are successful mechanisms [18,19]. The challenges that researchers face when developing evaluation criteria for science parks include the following: (1) differences in the objectives of the stakeholders [9]; (2) lack of cooperation from the incubated firms for in-depth empirical work; and (3) lack of consensus on the type of evaluation criteria to be used [13]. One way of evaluating an incubator is to identify the value added contributions to tenants firms [20]. In the business incubation literature, the term *value added* refers to the specific ways that an incubator enhances the ability of its tenants to survive and grow in business through its programs [21].

The science park's value added dimensions employed in this research can be summarised as business support services and social support services. The authors have based this classification on studies that use specific services characteristic of university business incubators as evaluation indicators. Löfsten and Lindelöf [9] underline the importance of facilities management, in which they incorporate location, infrastructure, and urban planning, by comparing the performance of on-park and

[2] OECD, The Organisation for Economic Co-operation and Development, is an international economic organisation of 34 countries founded in 1961 to stimulate economic progress and world trade. [http:// http://www.oecd.org]

off-park firms. They argue that on-park firms have a superior performance, especially due to the facilities offered, as they effectively support both formal and informal networks. Mian [20] refers to business support services as typical university incubator services that include rent breaks, shared office services, business assistance, and access to capital. He also analyses university-related services such as those provided by student employees, faculty consultants, and the university's institutional support system around the facility; in this study, these were termed social support services.

Chan and Lau [6] suggest a framework based on structural theory and cluster theory. The first theory supports the assertion that incubatees can gain access to structural elements provided by the science park and, therefore, that synergy will be generated between and among high-tech firms [22,23]. Chan and Lau divide these services into basic structural support (shared office services, business assistance, and access to capital) and technology-related structural support services (labs and workshop facilities, research and development activities, and technology transfer programs). The second theory (cluster theory) supports the argument that high-tech firms with similar characteristics and within the value chain would be attracted to cluster together in the science park. Consequently, this will lead to superior access to knowledge that enables the incubated firms to establish competitive advantage [24]. In this case, the science park would act as a catalyst, being the ideal environment for internal networking; however, without special policies from the management side, the tenant companies would remain isolated. Therefore, business networking, both internal and external, occurs through the social programs and services that the science park management offers.

Bergek and Norrman [16] proposed an evaluation framework divided into three categories: selection (the strategies and policies used for accepting or rejecting ventures), business support (the degree of support and business assistance provided by the incubator) and mediation (how the incubator connects the incubatees with the environment). Once again, business support refers to the physical space and business counselling. The environment comprises the internal interaction between the tenant companies and the external relationships of the tenant company, either business-to-business (with an outside company) or with academic institutions, such as universities. Seeking an answer to the question "What is the process of business incubation that occurs within business incubators?" Hackett and Dilts [25] developed an evaluation guide based on three constructs: selection performance, monitoring and business assistance intensity, and resource munificence scales.

Trying to answer the same question, a two-sided approach had been used in evaluating the monitoring and business assistance construct: items that measured time intensity (use) and items that measured quality (value added). The first items measure the time intensity aspects of the strategic management of the incubator and the incubatees: the validation of potential strategic service providers, provision of strategic planning and operations assistance, and interacting with the incubatees. After the empirical analysis, five factors were retained as significant: the incubator manager devotes sufficient time to assist and interact with the incubatees, the incubator excels at providing operations-related advice to the incubatees, provides access to marketing specialists, and maximises network contacts as well as the knowledge sharing process between incubatees.

3. METHODOLOGY

3.1 Data source and sample

The proposed evaluation questionnaire is based on Mian's study [20], which was created with a similar aim and scope and applied to United Kingdom science parks. A literature survey was conducted covering science park topics and entrepreneurial aspects to validate the evaluated services as being of high importance for tenant companies. The survey is based on Likert scales of three or four grades, as we wish to measure the frequency of use of certain services, the degree of involvement of the park's management, and the value added contributions of certain factors. Open questions were also included with the purpose of gathering further information on services that were not mentioned in the survey, as some services might be typical only of certain science parks. The data collection for the empirical work had been carried out using *ad-hoc*[3] questionnaires that were addressed to companies from various science parks. The authors considered not only current incubated firms, but also firms that have already graduated. By comparing the results, we want to confirm whether graduated firms value the services of the science park more than current resident firms.

[3] *Ad hoc* is a Latin phrase meaning "for this." It generally signifies a solution designed for a specific problem or task, non-generalizable, and not intended to be able to be adapted to other purposes.

To validate the proposed questionnaire, it was tested on firms from several Catalonian science parks. This autonomous region was chosen as the starting point for the study because of its high concentration of science parks, with 26 percent of all Spanish science parks[4]. As part of the sample, it shall consider actual incubated firms along with firms that have graduated and left the park premises. For all these reasons, the aim of this study is to evaluate the services that the Barcelona Science Park (PCB) offers to its tenants by gathering information from those companies currently located in the park and those that have graduated. The park is home to 4 research institutes, 75 companies, an incubator for biotechnology companies, more than 70 research groups, and a wide range of research support technology. In addition, it organises more than 120 activities for the promotion of scientific culture and new careers in science, which close to 6000 people participate in each year. The study offers first-hand information about the advantages and disadvantages that a science park linked to a university offers.

The questionnaire was sent out in June-July 2010 via email to managers of the companies. The response rate was 60 percent for incubated companies and 33.33 percent for the graduated ones, with a confidence level of 95 percent.

3.2 Variables and analysis considerations

As mentioned, it is evaluating the science park from two perspectives: basic business support services and social support services. Business support refers to the incubator facilities that include office space, services, and incubator management. Moreover, service resources provided by the incubator refer to secretarial services, conference facilities, canteen, and car parking, which are usually much less costly than that of individual premises and services [26]. The resource-based view of the firm is used to investigate how the deployment of key resources in the university science park, namely business support, changes during the lifecycle development of small entrepreneurial firms [27]. The same authors concluded that such facilities allowed firms to organise and commence trading relatively quickly because the incubator minimised many of the challenges associated with the practical side of the new venture creation process.

The survey contains questions relating to office space [9,20,21] and its cost. Rental subsidies are the main attraction for firms when they choose to locate in science parks because it is generally believed that cost considerations are of utmost importance at the beginning of start-ups [6]. For this reason, it is important to understand the office space in terms of its size in square meters and scale valuation (plentiful, sufficient, or very crowded) and the rent cost associated with that space (low, medium, or high). Further questions are representative of the assessment of basic support services and refer to laboratory space and equipment, copy and printing machines, library facilities, internet access, and the availability of conference and meeting rooms, cafeteria, reception, security, and maintenance services [6,20,28,29]. All these services fall into the category identified by Chan and Lau [6] as "sharing resources." In a multiple case study, Mian [20] identifies the relationship between the firm's degree of involvement in services and the value added by each of those factors. A hypothesis to test in this case is whether *firms that do not use these services or use them very infrequently would consider them valuable for the firm's development in the future*.

Another key point to examine is the assistance that science park management provides to tenants in finding and obtaining government grants and loans or sources of venture capital [6,20,30,31]. Significant correlations between the park's involvement and the value added are expected from the answers given in response to the questions about funding assistance. The study aims to determine whether there is a preference for using the assistance offered by the science park that depends on the nature of the funding: public or private.

Formation and coaching are important areas to analyse. Effective incubator management can ensure that firms have access to business advice resources, including specialist programs and seminars [13]. Business advice includes advice acquired either from the persons employed by the incubator or by consultants recommended by the incubator administration [32,33]. Such business assistance services evaluated in our questionnaire refer to marketing, accounting, legal, taxation [6,20], recruitment services [6,9,20], intellectual property protection advice, and market access [6,9,15]. One method of delivering business assistance services is to organise training sessions regarding business matters [6],

[4]Spain is among the countries that invest heavily in these institutions, with 77 parks currently registered by APTE, and which are located in 17 different autonomous communities. The companies and institutions located in those parks are the best reference for the Spanish system of innovation. In Catalonia alone, no less than 20 parks are registered, making it the region with not only the highest number of parks but also an interesting environment for our study.

and a question that addresses this point has been included. Participating in such training sessions brings other benefits because this is a good opportunity to interact with other tenants. This leads us to the next phase of our survey: an analysis of the social support services provided. Informal and personal connections are often as important in promoting innovation and the development of synergy as the establishment of more formal research relationships [23]. We decided that it was worth inquiring whether on-park or off-park firms are preferred at the moment of establishing formal relationships (referring to partnerships or mixed research units in this study). McAdam et al. [34] emphasise an important avenue of research in relation to the social support services provided by science parks; i.e., the entrepreneurial network. Clustering effects include access to knowledge resources and the venture capitalist attraction that is related to the incubator image and the provision of credibility as well as the generation of collective knowledge and learning among its member firms [27]. Association with the science park image may increase credibility with customers and suppliers as it shows professionalism, but might also suggest that the company is still "in diapers" and cannot survive on its own [35].

The networks created in the science parks form a complex and dynamic system based on information and social exchange [36]. The main contributions provided by entrepreneurial networking lie in the possibility of supplying new ideas and information that support the growth of small firms, as mentioned by McAdam et al. [34]. Entrepreneurial networks facilitate the formation of alliances with reputable partners, and this can influence the credibility and reputation of the firm. According to Neergaard [37], the role of the networks is based on the notion that entrepreneurship is embedded in a social context and that it is channelled and facilitated or constrained and inhibited by people's position in social networks, as Aldrich et al. [38] argue. Entrepreneurial networks are flexible, fluid, and adaptable to the firm's changing requirements over time [34], and this is a basic requirement for surviving in a constantly evolving business environment. Proximity to firms engaged in similar activities may provide knowledge that is more current for firm innovation than may be true when knowledge travels between firms that are distant [39]. Close proximity to firms engaged in similar activities is recognised as a positive aspect, as it facilitates networking and discussions about common problems and challenges; but entrepreneurs are often reluctant to share too much information with fellow tenants as they fear their ideas and strategies might be poached [35]. Several questions have been designed to evaluate the degree of knowledge shared among the firms incubated in the science park[5], but we also want to gain better insight into the internal social events that take place in the park and whether fellow incubatees share business advice or strategies with each other [25]. Our goal is to determine whether these so-called networking advantages exist or whether they are viewed more as a political argument to justify government investment in establishing science parks [6].

A science park also facilitates interaction between the firms located in a science park and local universities, as they are considered knowledge spillovers that in the long run contribute to enhance the innovative performance of the tenants [40]. Knowledge spillovers are the direct or indirect transfer of knowledge from one party to another. Proximity to universities and intensive university connections are an important part of the social support that a company can benefit from when locating in a science park. The university link will allow access to specialist skills-based labour and will make the firm known to students. An incurred benefit may be the reduction in costs [26] and the ability to provide a guarantee to the customer that products or services are based on the latest knowledge available [41]. As Fukugawa [42] argues, small firms with severe resource constraints are likely to exploit university knowledge in search of solutions to immediate problems in the production or development process, but only when the firm possesses a high absorptive capacity.

Löfsten and Lindelöf [9] distinguish between university spin-offs and spin-offs from corporations as types of high-technology based firms. Their results show that university spin-offs place a greater emphasis on co-operation with universities and formal contacts with academics in the university; thus, the research linkages are greater among university spin-offs. In another paper, the same investigators argue that that new technology-based firms working with universities have closer proximity that achieves certain advantages and promotes the exchange of ideas through both formal and informal networks than firms that are located outside science parks. Vedovello [43] grouped the types of collaboration between park companies and universities into three categories. The first type includes

[5]Tenant companies were asked to rate sentences such as: *The science park management organises events and meetings that facilitate the interaction with other incubated firms; Between the incubated firms in the science park, a social network has been formed; Knowledge is shared among the firms incubated in the science park; I often consult with other incubated firms for business advice; The reputation of my company is enhanced because of the association with the science park image*.

formal links, such as research contracts or analysis and testing; the second type includes human resource links, such as sponsoring student projects or recruiting graduates; and the third type includes informal links, such as personal contacts with university staff, attending seminars, or accessing libraries. Our aim is to determine what types of relations are more likely to be established with the university and the impact of these relationships on the performance of the company. Undoubtedly, science park managers have an important role not only in establishing links, but also in encouraging the development of more formal links over time. How well do they fulfil these tasks? We consider that this is for the tenant companies to say.

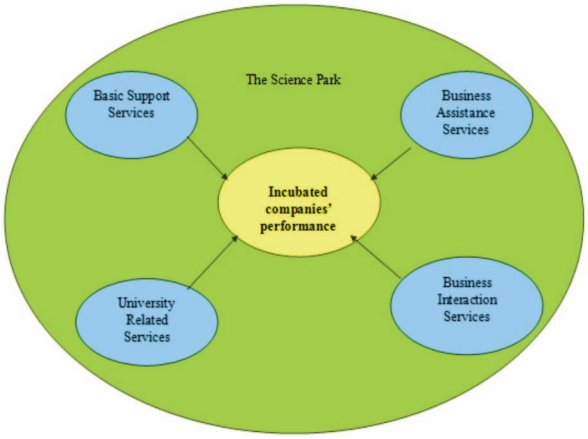


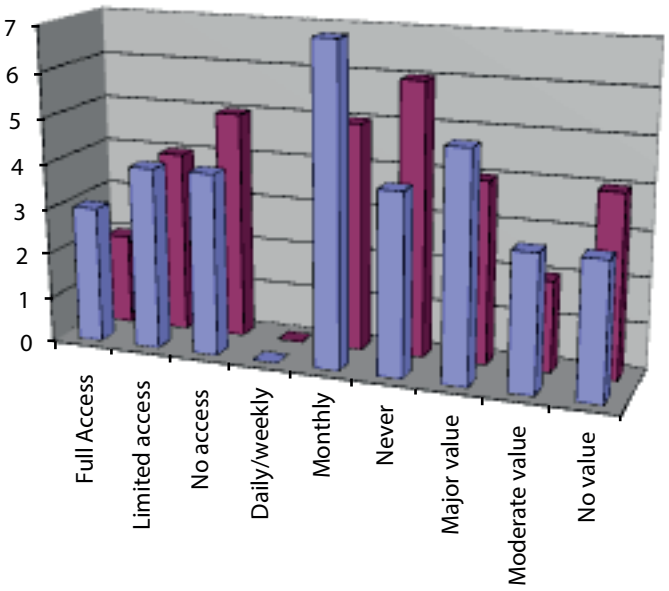
Figure 1. Science park environment

4. RESULTS AND DISCUSSION

By comparing results obtained from the two groups of companies (incubated and graduated), we expected to identify statistical differences in the perception of which services these companies had benefited from during their stay in the park. This could be useful in determining what could be done to improve those services that lack the desired feedback and are marked as unsatisfactory. The services studied include rented space, labs, conference rooms, libraries, marketing services, formation courses, and networking meetings.

The office space is considered as adequate for their needs. The average space occupied by a company is 29.5 square meters, with a minimum of 12 and a maximum of 50 square meters (mode 13 m^2, median 26 m^2). Although the surveyed companies are satisfied with the office space that they occupy (on average), they consider the renting price is too high for being located in a science park, leading to the conclusion that there are no perceived benefits from renting a smaller or bigger office.

Some companies declare limited access to labs and equipment, copy machines, and conference rooms. Usually, they have been using conference rooms on a monthly basis. This is rated as an important service, and their opinion is that it adds a moderate value to them. Laboratories have an irregular valuation. Companies that actually need and use laboratories and scientific equipment declare a benefit from this service and attribute a major value to the development of the company, but others do not. Regarding access to the basic support services identified above, it appears that access to library resources and printing machines are the most restricted. The park library service is almost never used and provides no value for the companies in question. In contrast, the university's library service was more used and valued by the tenants. According to the survey results, 44 percent of the incubatees report high involvement in the use of this resource and 55 percent attribute a major value to these services. This shows that universities generally have well-documented centres with research materials and provide access to databases and files that are otherwise restricted or require an additional cost for access (Figure 2).



	Full Access	Limited access	No access	Daily/ weekly	Monthly	Never	Major value	Moderate value	No value
Government grants and loans	3	4	4	0	7	4	5	3	3
Outside capital- venture capital	2	4	5	0	5	6	4	2	4

Figure 2. Use frequency

As for access to printing machines, this appears not to be a problem because most of the companies declared that they never used this service and attributed no value to it. For services such as the cafeteria, security, maintenance, and reception, the feedback was positive. All services have a high accessibility rate, approximately 83 percent, and all were rated as important for the welfare of the company, adding major or moderate value to daily operations. Other services, such as access to recycling and cleaning services, were regarded as very important and are also provided by the science park.

Table 1. Basic Support Services-Access, Value Added

	Full Access	Limited access	No access	Daily / weekly	Monthly	Never	Major value	Moderate value	No value
Labs & Equipment	4	5	3	4	4	4	5	4	3
Fax & telephone	9	1	2	10	1	1	7	4	1
Internet	10	0	2	11	0	1	10	1	1
Copy machines	5	5	2	5	3	4	2	6	4
Printing machines	3	2	7	3	1	8	2	2	8
Library	3	1	8	3	2	7	4	1	7
Conference rooms	7	5	0	2	10	0	5	6	1
Coffee shop	10	2	0	9	2	1	4	7	1
Security	10	2	0	9	1	2	6	6	0
Maintenance services	7	4	1	5	7	0	8	4	0
Receptionist	12	0	0	12	0	0	10	2	0

The most important assistance services include access to marketing services, as these are fundamental in promoting any business. This is supported by 63 percent of the tenants from PCB, who attribute a major value to this service, and 27 percent who rate this service as of moderate value. Assistance services in finding funding sources appear to be identified as limited, mainly for assistance with government and private grants. More than one third (43 percent) of companies declared that this

service added value, but less than 33 percent rated it as moderate, and 25 percent said that it has no value for them (Figure 3). Surprisingly, services that might be considered of high importance for technology-based companies, such as the protection of intellectual capital and access to markets, prove to be of limited access (>27 percent) or not accessible at all (63 percent). Still, this does not appear to be a problem because the surveyed companies declared that they never use these services (>63 percent); only 34 percent considered the consulting services that aid with the protection of intellectual capital as adding major value to their business, and 45 percent rate the consulting services regarding market access as of major value.

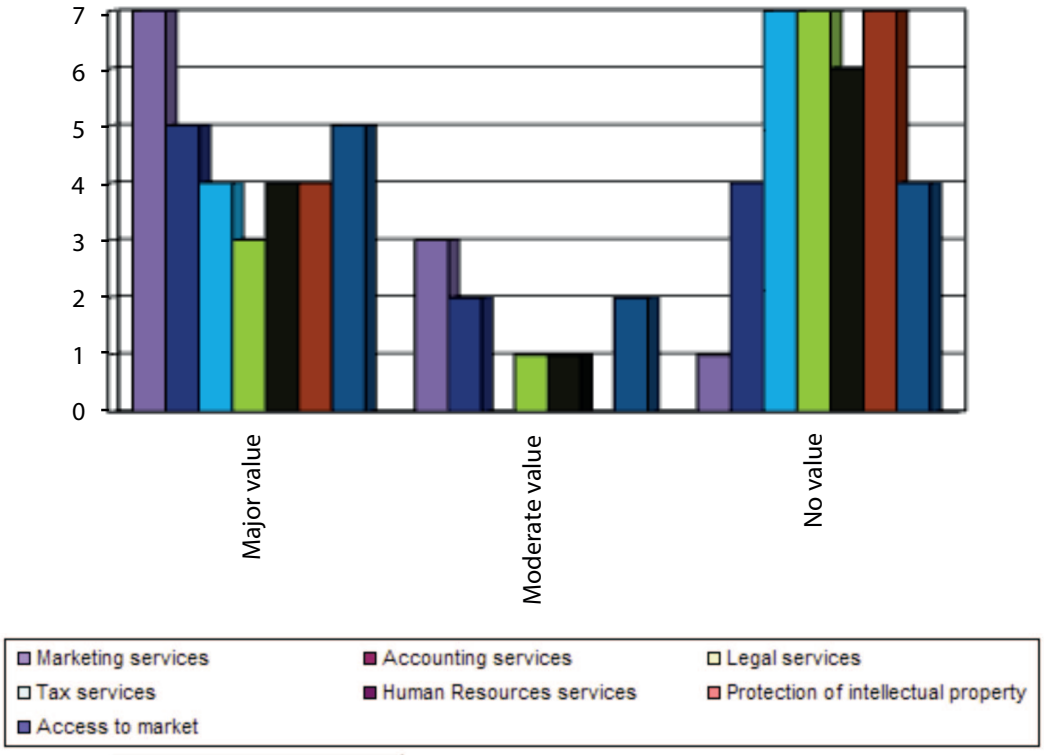


Figure 3. Business assistance services – Added value

After analysing some questions about managerial training, such as whether the respondents have attended courses related to business or free courses offered by experienced people organised by the science park management, it was apparent that half of the surveyed companies are unaware of such programs. They consider that it might be a good idea, but never had time to attend such courses. Less than one third of the companies (30 percent) admit to being aware of such training opportunities, but only 20 percent have attended such courses thus far. We must emphasise the benefits of participating in such training courses. Few companies take advantage of this opportunity to interact with other tenants who can be potential business partners or sources of information related to any aspect of a business. When asked whether they attend training or foreign languages courses at the university, most of the tenants declare that they generally do not engage in such activities (88 percent), but 33 percent consider that this service might strongly contribute to their business.

Seventy percent of the surveyed companies agree that one key factor for a company at science parks should have to be part of a social network that forms the park itself. In addition, 44 percent of the surveyed companies state that the science park manager is directly involved in promoting interaction inside the park and always seeks to improve the level of satisfaction of the tenants. Any efforts of the science park management in this direction are at least of moderate value for the tenants. Apart from the networking cocktail events that the park organises, the tenants are expected to interact for research purposes, and this is an advantage that only incubation programs offer. Informal and personal connections are often as important in promoting innovation and the development of synergy as the establishment of more formal research relationships [23]. The ability to extend personal relationships

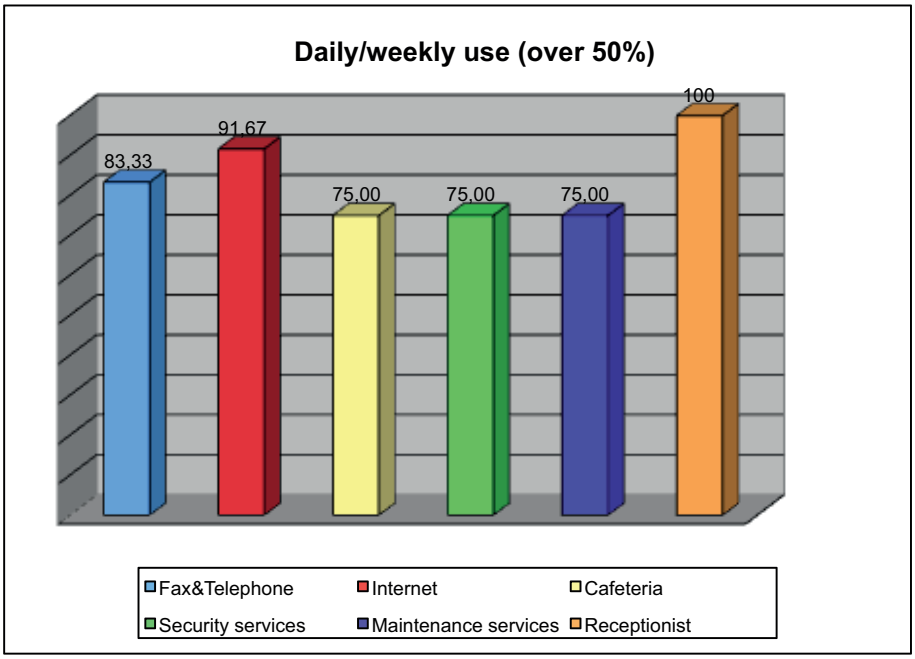


Figure 4. Business assistance services-access, Use, Added value

by connecting to new networks is crucial. Effective use of group events and networking cocktail events enables entrepreneurs to build trust and determine mutual expectations and obligations. More than half of the surveyed tenants (54 percent) admit than they interact amongst themselves for research purposes, and 18 percent strongly support this affirmation. Another 18 percent contradict this supposition and disagree with respect to any interaction with another tenant for research purposes. The data also show that 70 percent of the PCB tenants agree to discuss business matters amongst themselves. Although the tenants agree that a social network has been formed among the incubated firms, when it comes to sharing business knowledge, the incubatees are more reluctant and prefer to keep business information to themselves; only 44 percent appear to agree with sharing business-related information. This does not strongly support the theory that knowledge spillovers are generally associated with science and technology parks. Young companies may not have the necessary business knowledge to share with fellow companies or it may be viewed as a matter of competitiveness.

The image of a company located at a science park could be relevant for every one of them. The companies located at PCB appear to agree that their reputation is enhanced by their association with PCB. Being associated with the Barcelona Science Park adds major value to their business, according to 77 percent of the surveyed tenants, by making them seem more trustworthy in the eyes of their creditors and suppliers. These companies do not think that their credibility is negatively affected, nor do they view themselves as still "in diapers and unable to survive on their own."

The feedback received regarding the openness of the university staff to collaboration with the incubated companies is generally positive; more than 55 percent of companies state that they had no problem in establishing contact with the academic world. The other 44 percent remain neutral on this aspect, most probably because they have not yet attempted any contact with the university staff. With respect to the impact that the university image has on the reputation of the science park, the results are good, but not at the same level as when discussing the image associated with location in a science park. In this context and assuming that the companies that remained neutral (55 percent) have not had any involvement with university related services, the results show than the image of the university enhances the reputation of the company. This is supported by the 88 percent of the surveyed companies that attribute at least moderate value to the importance of the university image for their business.

Proximity to university and intense university connections is an important part of the social support that a company can benefit from by locating on a science park, according to our survey of the literature. As said at the outset, the cost reduction associated with access to the use of university resources, either labour or equipment and laboratories, is a considerable advantage. Still, no major involvement in hiring

students has been detected, likely because students might lack expert knowledge and skills that biomedical research companies need. Therefore, only 44 percent of the surveyed companies declare that they occasionally hire student employees and use the university equipment and laboratories. On the other hand, the surveyed companies attribute a slightly higher value added to the use of the labs, with 55 percent admitting that this service is of major value to the company.

Analysing the level of interaction with the university, there is a 55 percent rate of occasional involvement in attendance at university workshops; but interaction with faculty consultants is a bit disappointing, as 55 percent of those from PCB admit they have never contacted university staff on consulting matters. As for the value added, the workshops organised by the university appear to have a high contribution for 33 percent of the tenants and a moderate contribution for 44 percent of them. Again, the consulting services that university staff may be able to offer are less valued; only 33 percent see this service as having a major value, whereas 44 percent consider that it does not contribute whatsoever to their business. When it comes to collaboration with the R&D departments of the university, the results are a bit better. There is a very small rate of high involvement (22 percent), but around 44 percent of the companies declare that they occasionally collaborate with university staff for research purposes. This appears to be of major value for 44 percent of the surveyed tenants, as the university staff are qualified personnel, and their contribution to research projects has a major impact.

One of the roles of the science park manager is to improve communication between university centres and hosted companies, thereby strengthening the relationship between the academic world and applied researchers. After testing this idea with the PCB tenants, we found no solid proof to sustain the idea that the science park management fulfils its role as an ambassador for the incubated companies. Most of the surveyed companies remained neutral when asked if the science park management provides support in establishing firm-university connections; however, more positively, 33 percent agree with this affirmation. The neutrality of the other 66 percent may be caused by the fact that they might not have requested assistance on this matter or they might not yet have been involved with the academic world.

When compared with Mian's study of U.S. university incubators, some similarities and differences appear. The most similar results are seen for the basic support services and the infrastructure the park offers. Major value added has been attributed to the same services, but the importance given to access to copy machines and telephone might be an exception, being replaced today by the internet and other communication technologies. As for business assistance, services related to marketing reported major value in both studies. Assistance with legal or governmental regulations, human resources, and tax matters did not show significant associations between their use and value-added contributions in any of the studies. However, significant results were found in both cases in providing internal and external business networks. The only difference would be in the use of these services. It seems that young American managers communicate more and interact more easily than Spanish managers. Seeing an opportunity and admitting that it adds major value to a start-up company is not sufficient if there is no collaboration.

The university connection plays an important role by providing infrastructure and support that nurtures young technology-based firms. From the university point of view, the results are again quite similar. Collaboration with the university environment is rated in most cases as very valuable. It is agreed both by American and Spanish managers that the university provides access to scientific resources, such as well-documented libraries and appropriate laboratories and equipment for research purposes. Nevertheless, the interaction rate remains a problem, as it is very low in both cases, with only slightly better perspectives in the American case.

The main challenge is that to make the university technology business tool more attractive to the entrepreneurial university, perhaps more self-sustainable models will have to be developed [20]. As for the Spanish start-up companies, there is room for improvement regarding the social aspect. Interaction with other tenants must increase, so that the benefits of the social network can reach their maximum; this requires constant knowledge sharing, strong business connections, and increasing the rate of innovation of products and ideas. Science and technology parks should be able to integrate scientific, technical, and social capabilities, thus facilitating the creation, transfer, dissemination, measurement, and management of knowledge, and its application to production activities. Several young companies located in the Barcelona Science Park have been surveyed in a precise manner to test how well science parks perform in their stated objectives.

5. CONCLUSIONS AND FUTURE RESEARCH

The increasing number of science parks in Spain and the magnitude of this phenomenon suggest that they are successful mechanisms for the development of technology-based firms. No empirical evidence suggests the contrary or criticises the success of Spanish science parks, but the existence of international studies that refer to science parks as "enclaves" of innovation [18,19] has to be considered. Indeed, many researchers have demonstrated empirically that in most cases, the benefits incurred for firms located in science parks are numerous and go beyond rental subsidies or other physical resources. To be a full member of the Association of Science and Technology Parks of Spain (APTE), some requirements need to be met, such as the existence of formal and operational links with universities, research centres, and other higher-education institutions. Additionally, they must have a team of professionals that is integrated into an *ad-hoc* company or institution and specialised in science or technology park management to promote technology transfer and encourage innovation between the companies and organisations established in the park. Nevertheless, we are not aware of any method of measuring the interaction between tenant firms and universities, nor do we have any proof to support the existence of technology transfer between tenants in Spanish science parks. Given the fact that the cultural factor might impact the efficiency and success of science parks differently, we cannot always apply theories, although empirically demonstrated, developed in one country to another. For this reason, a national assessment survey will give us more information on how things function inside a science park, at what points an incubator of this kind excels, and also where it needs improvement.

This paper represents the beginning of what we intend as an assessment project of Spanish science parks at a national level. The questionnaire was based on Mian's study [20] and followed the same basic structure: identifying the value added provided by science park services. It is natural to assume that services that are used more often are the ones that add value to the company; however, we expect to see that services that are less used at the moment of assessment might still be considered as valuable for the company in the future.

The proposed questionnaire will be first tested on firms from several science parks from Catalonia, an interesting region to study because of the high number of science parks, which will serve very well for validation purposes. As part of the sample, we shall consider both actual incubated firms and firms that have graduated and left the park premises. Because these firms are now on their own, we expect to see differences in how they perceived the value added of the parks' services because their evaluation will include the entire incubation period, not only the first year as might be the case for incubated firms. By comparing answers from the two categories of firms, we hope to anticipate future problems that incubated firms might encounter and identify services that are more relevant to adding value to a company.

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REFERENCES

[1] Association of Science and Technology Parks of Spain (APTE). (2006) A study on the socio-economic impact of Spanish science and technology parks. (Available online at http://www.apte.org/documents/libros/Estudio_de_Impacto.pdf).

[2] Santamaria L., García M.A., & Rialp J. (2002) Documents de treball d'economia de l'empresa. Caracterización de Las Empresas Que Colaboran Con Centros Tecnológicos. Universitat Autònoma de Barcelona. (Available online at http://webs2002.uab.es/dep-economia-empresa/documents/02-5.pdf).

[3] Roure J., Condom P., Rubiralta M., & Vendrell M. (2005) Benchmarking sobre parques científicos. (Available online at http://www.gen-es.org/12_publicaciones/docs/pub_47_d.pdf).

[4] Ondategui, J.C. (1999) Redes de Innovación y Desarrollo Regional en el Noroeste Peninsular. *Revista de estudios regionales,* (55) 77–108.

[5] Triadó X., Aparicio P., & Jaría N. (2008) Externalidades positivas de los elementos organizativos en los parques científicos para la aplicabilidad de la investigación. El caso de la Universidad de

Barcelona. *Master research paper*. Máster Oficial de Investigación en Empresa, Finanzas y Seguros (Universidad de Barcelona).

[6] Chan K.F., & Lau T. (2005) Assessing technology incubator programs in the science park: The good, the bad and the ugly. *Technovation* (25-10) 1215–1228.

[7] International Association of Science Parks. Science Park definition (Available online at http://www.iasp.ws/publico/index.jsp?enl=6>.)

[8] Lindelöf P., & Löfsten H. (2004) Proximity as a resource base for competitive advantage: University-industry links for technology transfer. *Journal of Technology Transfer* (29-3/4) 311–326.

[9] Löfsten H., & Lindelöf P. (2005) R&D networks and product innovation patterns - academic and non-academic new technology-based firms on science parks. *Technovation* (25-9) 1025–1037.

[10] Dettwiler P., Lindelöf P., & Löfsten H. (2006) Utility of location: A comparative survey between small new technology-based firms located on and off science parks - implications for facilities management. *Technovation* (26-4) 506–517.

[11] Westhead P. (1997) R&D 'inputs' and 'outputs' of technology-based firms located on and off science parks. *R and D Management* (27-1) 45–61.

[12] Yang C., Motohashi K., & Chen J. (2009) Are new technology-based firms located on science parks really more innovative? Evidence from Taiwan. *Research Policy* (38-1) 77–85.

[13] Mian S.A. (1997) Assessing and managing the university technology business incubator: An integrative framework. *Journal of Business Venturing* (12-4) 251–285.

[14] Organisation for Economic Co-operation and Development (1999) *Business incubation: international case studies*. Paris.

[15] Koh F.C.C., Koh W.T.H., & Tschang F.T. (2005) An analytical framework for science parks and technology districts with an application to Singapore. *Journal of Business Venturing* (20-2) 217–239.

[16] Bergek A., & Norrman C. (2008) Incubator best practice: A framework. *Technovation* (28-1/2) 20–28.

[17] Fukugawa N. (2005) Characteristics of knowledge interactions between universities and small firms in Japan. *International Small Business Journal* (23-4) 379–401.

[18] Felsenstein D. (1994) University-related science parks - 'seedbeds' or 'enclaves' of innovation? *Technovation* (14-2) 93–110.

[19] Quintas P., Wield D., & Massey D. (1992) Academic-industry links and innovation: Questioning the science park model. *Technovation* (12-3) 161–175.

[20] Mian S.A. (1996) Assessing value-added contributions of university technology business incubators to tenant firms. *Research Policy* (25-3) 325–335.

[21] Allen D., & Bazan E. (1990) *Value-added contribution of Pennsylvania's business incubators to tenant firms and local economies*. Report prepared for the Pennsylvania Department of Commerce (Pennsylvania State University, University Park, PA)

[22] Maillat D. (1995) Desarrollo territorial, milieu y política regional. In A. Vázquez and G. Garofoli [ed.]: *Desarrollo económico local en Europa*, 37–51.

[23] Phillimore J. (1999) Beyond the linear view of innovation in science park evaluation. An analysis of Western Australian technology park. *Technovation* (19-11) 673–680.

[24] Tallman S., Jenkins M., Henry N., & Pinch S. (2004) Knowledge, clusters, and competitive advantage. *Academy of Management Review* (29-2) 258–271.

[25] Hackett S.M., & Dilts D.M. (2008) Inside the black box of business incubation: Study B - scale assessment, model refinement, and incubation outcomes. *Journal of Technology Transfer* (33-5) 439–471.

[26] Markman G.D., Phan P.H., Balkin D.B., & Gianiodis P.T. (2005) Entrepreneurship and university-based technology transfer. *Journal of Business Venturing* (20-2) 241–263.

[27] McAdam M., & McAdam R. (2008) High tech start-ups in university science park incubators: The relationship between the start-up's lifecycle progression and use of the incubator's resources. *Technovation* (28-5) 277–290.

[28] Bollingtoft A., & Ulhoi J.P. (2005) The networked business incubator - leveraging entrepreneurial agency? *Journal of Business Venturing* (20-2) 265–290.

[29] Colombo M.G., & Delmastro M. (2002) How effective are technology incubators? Evidence from Italy. *Research Policy* (31-7) 1103–1122.

[30] Plosila W.H., & Allen D.N. (1985) Small business incubators and public policy: Implications for state and local development strategies. *Policy Studies Journal* (13-4) 729–734.

[31] Smilor R.W. (1987) Managing the incubator system: critical success factors to accelerate new company development. *IEEE Transactions on Engineering Management* (34-3) 146–155.

[32] Lee S.S., & Osteryoung J.S. (2004) A comparison of critical success factors for effective operations of university business incubators in the United States and Korea. *Journal of Small Business Management* (42-4) 418–426.

[33] Rothschild L., & Darr A. (2005) Technological incubators and the social construction of innovation networks: An Israeli case study. *Technovation* (25-1) 59–67.

[34] McAdam M., Galbraith B., McAdam R., & Humphreys P. (2006) Business processes and networks in university incubators: A review and research agendas. *Technology Analysis and Strategic Management* (18-5) 451–472.

[35] McAdam M., & Marlow S. (2007) Building futures or stealing secrets? Entrepreneurial cooperation and conflict within business incubators. *International Small Business Journal* (25-4) 361–382.

[36] Birley S. (1985) The role of networks in the entrepreneurial process. *Journal of Business Venturing* (1-1) 107–117.

[37] Neergaard H. (2005) Networking activities on technology-based entrepreneurial teams. *International Small Business Journal* (23-3) 257–278.

[38] Aldrich H., Zimmer C., & Jones T. (1986) Small business still speaks with the same voice: a replication of the voice of small business and the politics of survival. *The Sociological Review* (34-2) 335–256.

[39] Gilbert B.A., McDougall P.P., & Audretsch D.B. (2008) Clusters, knowledge spillovers and new venture performance: An empirical examination. *Journal of Business Venturing* (23-4) 405–422.

[40] Squicciarini M. (2009) Science parks: Seedbeds of innovation? A duration analysis of firms' patenting activity. *Small Business Economics* (32-2) 169–190.

[41] Zucker L.G., Darby M.R., & Armstrong J.S. (2002) Commercializing knowledge: University science, knowledge capture, and firm performance in biotechnology. *Management Science* (48-1)138–153.

[42] Fukugawa N. (2006) Science parks in Japan and their value-added contributions to new technology-based firms. *International Journal of Industrial Organization* (24-2) 381–400.

[43] Vedovello C. (1997): Science parks and university-industry interaction: Geographical proximity between the agents as a driving force. *Technovation* (17-9) 491–502.