Real estate resourcing on science parks

Real Estate Resourcing on Science Parks: Exploratory Overview of European Science Parks

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Abstract: Science parks (SPs) are believed to enhance among others the knowledge management process (knowledge creation, retention, and transfer), and also commercialization of knowledge. Although SPs are established globally for decades, there is limited research concerning the characteristics of these real estate infrastructures. This paper aims to give an overview of how real estate resourcing in the European SP context is achieved. Prior research focused mainly on the impact of SPs on facilitating the innovation process and contributing to economic output. Less attention is given to possible heterogeneity in characteristics of SPs. A survey on SP characteristics is distributed among all known SP managers/owners in Europe in order to collect data on both physical and non-physical characteristics of these SPs. The survey sample consists of 82 cases among 16 European countries, which results in descriptive data on physical and non-physical characteristics of the SP field. The selected variables of SP characteristics are based on prior academic research. The total list of SPs is compiled through desk research, such as case studies in empiric research, member lists of SP associations and other registers. The paper gives an explorative overview of SP literature and a descriptive analysis of the physical and non-physical characteristics of SPs in the European context. It is a starting point for advancing the academic debate on the real estate context of knowledge management and offers practitioners trends in SP composition.

Keywords: Resourcing and implementing, SPs characteristics, knowledge management, case studies, contextual analysis

1. Introduction

Within the resource portfolio of intellectual capital management, buildings or real estate are one of the physical resources that firms own or have access to (Roos et al, 2007). Infrastructures that co-locate firms and institutions conducting knowledge-related activities are considered science parks (SPs) (Zhang, 2002). SPs could play an important role beyond the firm level: Firstly, as a visible sign in the region as knowledge hotspot. Secondly, its infrastructure facilitates an environment for conducting research and development activities (R&D). Thirdly, supporting firms with administrative, management or technological services. Lastly, networks of SPs involve interactions between knowledge producers, users and disseminators (Saublens, 2007). SPs are believed to encourage knowledge transfer from research to markets (Durão et al, 2005; Saublens, 2007), networking (Hansson et al, 2005; Löfsten and Lindelöf, 2005), new firm creation (Löfsten and Lindelöf, 2005), and patenting activity (Squicciarini, 2008; Lamperti et al, 2017). The first SP is Stanford Research Park, established in the United States in 1951 within a suburban area in proximity of the university (Frej et al, 2001; Annerstedt, 2006). The first European SPs were established in the United Kingdom and France in the 1960s with a large growth in numbers between the 1980s and 1990s (Storey and Tether, 1998). To date, little is known about how SP infrastructures are characterized in relation to knowledge management (KM). Argote et al (2003) state that KM outcomes are related and consist of knowledge creation, retention, and transfer. SPs could function as knowledge management systems, which are technical, organisational and managerial structures designed to support these KM outcomes (Massa and Testa, 2009). Hansson (2007) argues that within the knowledge-based economy SPs should play an essential role, otherwise these infrastructures will merely be remains of the industrial society. In addition, SPs are often financed by governments or public agencies, which heightens the need for accountability (Monck and Peters, 2009). The lack of insight on SP characteristics that could contribute to KM emphasizes the relevance for filling this knowledge gap. Therefore the main research question is: *what are the main SP characteristics in Europe and which KM outcomes can these characteristics support?* This paper provides an explorative overview of the SP resourcing in the European context based on a survey conducted among a sample of SPs. The paper is structured as follows, first a literature review on park characteristics is presented. Secondly, the methodology consisting of a survey on park characteristics among European park managers is discussed. Then results of the survey are presented with an outline of the European context. Finally, the conclusions and limitations are discussed.

2. Science park characteristics

2.1 Physical characteristics

A main part of the offering of SPs are their facilities and services. Facilities consist of “low tech” facilities, such as meeting rooms, cleaning and security, business plan support, while “high tech” facilities are laboratories, exhibition and piloting space, showrooms, and clean rooms (Van Winden and Carvalho, 2015). In addition, other leisure and supporting facilities are present at certain SPs, such as sports accommodations and restaurants (EIB, 2010). Saublens (2007) proposes that low-tech facilities should also include support services (i.e. administrative, managerial and technological support). Facilities and services can be designed for shared use to reduce costs for tenant firms and contribute to knowledge transfer through interaction (Dettwiler et al, 2006; Van De Klundert and Van Winden, 2008). The urban context of SPs has changed over time: specifically the relation between the SP and the city (Curvelo Magdaniel, 2016). Lamperti et al (2017) propose that SPs should at least accommodate one incubator or research institution. Technology incubators as a particular form of business incubation programs are specifically aimed at technology-oriented entrepreneurs in the early phases of business development (OECD, 2010). The park appearance contrasts among the relative smaller incubator-style with a high building density, medium sized park-style, campus with a low building density, and larger city/region-style (Zhang, 2002).

2.2 Non-physical characteristics

As SPs have established for decades, the age since establishment of SPs has been of interest as an indicator for comparison (Link and Link, 2003). In addition, various ownership models have developed over time. Albahari et al (2013) make a clear distinction in their evaluation of firm performance in relation to the degree of university shareholding. Moreover, Dabrowska (2016) distinguishes ownership models of public and/or private and even university-government-industry partnerships (i.e. triple helix). Link and Link (2003) argue that in the US the most relevant classification is: 1) real estate parks without university affiliation, 2) university parks with tenant selection criteria, and 3) university parks without selection criteria. Tenant selection criteria are: active in R&D, technology-based, commitment of employing graduate students, and interacting with university faculty. From a strategic level, high-tech sectors covered on parks are amongst other biotechnology, computer sciences, electronics, etc. (WAINOVA, 2009; Sanz and Monasterio, 2012). Furthermore, park objectives can be divided in three categories: economic development, technology transfer, and local benefits (Shearmur and Doloreux, 2000). Moreover, Capello and Morrison (2009) posit that the variety of schemes is a result of the functions SPs may develop, such as knowledge creation and transfer, and a seedbed or incubator function for new technology-based firms (NTBF). The International SP Association states that the innovative and entrepreneurial climate should be managed (IASP, 2017). The impact of a management function that organizes activities has gained attention from authors (Westhead and Batstone, 1999; Siegel et al, 2003). They state that the management function can vary on an informal team, single on-site manager, or on-site management company. A key task of management is promoting networking in- and outside the park and the establishment of a local community (Capello and Morrison, 2009; Van Winden and Carvalho 2015). This community could involve both private organisations (i.e. start-ups, small-medium enterprises, large firms or multinationals) and public organisations (research institutes and higher educational institutions) (Hansson et al, 2005). The well-informed selection of organisations is another task of the management (Westhead and Batstone, 1999).

This literature review on park characteristics show that these infrastructures are multi-faceted real estate objects. The set of physical and non-physical attributes is diverse and a pivotal role is required for the SP management in order to contribute to knowledge-related objectives. The previous discussed park characteristics form the basis of a web survey in order to explore differences among European cases.

3. Methodology

3.1 Participants

The participants within this research are SP managers in Europe. In order to construct the SP population a desk research is conducted through compiling online sources, such as prior attempts of compilations, member lists of both international and national SP associations, and SP references in literature. International sources include the current member list of the IASP and the ‘atlas of innovation’ by WAINOVA (2009), which lists worldwide science, technology parks and innovation-based incubators. On national level, members from SP-related associations from various countries are used to triangulate and complement the international sources. Through cross-referencing among international and national lists and literature, a long list is produced of 689

European SPs. All SP managers of these locations were contacted through e-mail and 82 completed the survey (12%). Table 1 shows the respondents per country sorted by highest to lowest response. This reveals that 29 of the total sample consists of locations based in the Netherlands and the UK. The Netherlands in particular is overrepresented, while countries such as Germany, Spain, and Italy are underrepresented.

Table 1: Number of SPs per country

	Total	Response		Total	Response		Total	Response
The Netherlands	35	15	Norway	34	4	Bulgaria	3	0
United Kingdom	113	14	Portugal	16	4	Czech Republic	40	0
Spain	69	7	Austria	5	2	Finland	48	0
Italy	59	6	Estonia	4	1	Greece	6	0
Sweden	32	6	Iceland	1	1	Ireland	2	0
Switzerland	10	6	Poland	8	1	Latvia	3	0
Germany	110	5	Slovakia	2	1	Lithuania	3	0
Denmark	8	4	Slovenia	2	1	Luxembourg	2	0
France	51	4	Belgium	13	0	Romania	10	0

3.2 Measures

The physical and non-physical characteristics derived from literature are operationalized in table 2 and 3. Each variable is listed with the measurement level, values, and source.

Table 2: Operationalization of physical SP characteristics

Variable	Measurement level	Values	Source
Urban context	Categorical	city as the park city contains the park city overlaps with the park city touches the park city is disjointed from park	Curvelo Magdaniel (2016)
Number of buildings	Dichotomous	Single /multiple building	Zhang (2002)
Gross floor area Surface site area	Continuous	m^2	
Laboratories Incubators Pilot rooms Clean rooms	Continuous	m^2	Appold (2004); Van Winden and Carvalho (2015); Lamperti et al (2017)
Shared usage of R&D facilities	Dichotomous	Presence facility	Dettwiler et al (2006)
Working facilities Leisure facilities Other facilities Services	Dichotomous	Presence amenity	WAINOVA (2009); Sanz and Monasterio (2012)

Table 3: Operationalization of non-physical SP characteristics

Variable	Measurement level	Values	Source
Age	Continuous	Years	Link and Link (2003)
Ownership	Categorical	- University - Public - Private - University-public - Triple helix - University-private - Public-private	Siegel et al (2003); Alhabari et al (2013); Dabrowska (2016)
Technology sector groups covered	Dichotomous	Presence group	WAINOVA (2009); Sanz and Monasterio (2012)
SP objectives	Constant sum among 6 variables [100]	- Creation and growth of new firms - Industrial rejuvenation - Knowledge creation - Local benefits - Regional development - Technology and knowledge transfer	Löfsten and Lindelöf (2005); Saublens (2007); Cappello and Morrison (2009); Link and Scott, (2015)

Variable	Measurement level	Values	Source
Management function	Categorical	- On-site management company - Single on-site manager - Informal teams - No management function	Westhead and Batstone (1999); Siegel et al (2003); IASP (2017)
Networking on-site	Categorical	- … is actively promoted by site management - … is not one of the core priority of site management, but is supported - … is not explicitly promoted and supported by site management, residents network on own initiative	Capello and Morrison (2009); Van Winden and Carvalho (2015); IASP (2017)
Number of resident organisations	Categorical	- Between 50 and 100 - Between 100 and 200 - Between 200 and 400 - Between 400 and 600 - Between 600 and 1000	Link and Link (2003)
Different organisations	Dichotomous	Presence type	Hansson et al (2005)
Tenant selection criteria	Categorical	- Focus on R&D - Technological orientation - Commitment with academics - Quality of past research - Attract funding for research - No criteria	Link and Link (2003)

3.3 Procedures

Respondents were contacted through e-mail to complete the web survey. The number of questions was limited as much as possible to maintain a fair response rate. The survey was kept active within four consecutive months up until March 2017. Data from the cases were extracted to produce descriptive results that will be discussed in the following chapter. The results for dichotomous variables indicating presence or absence are presented in percentages, while continuous variables (m^2 or years) are described with range, mean, standard deviation, and where applicable missing values. Questions regarding surface area of R&D facilities proved to be difficult to answer by respondents. The amount of missing values suggest that the target group (CEO, managers, etc.) do not have this info at hand or locations are a certain size, which makes answering these types of questions difficult. However, the variable shared usage of each R&D facility did not have any missing values. Consequently, the provided information and the available data online per case are combined to create the categorical variable presence or absence of R&D facilities and the usage.

4. Results

4.1 Results physical characteristics

Within the urban context of the cases the largest portion, 32% is located within a city, 22% overlaps with the city, 23% touches the city, while 15% is disjointed from the city. The remaining 9% operate on multiple locations with examples in France, Denmark, and the UK. This reveals that at least 77% of the sample has some relation with the city. In terms of size, the sample contains both cases that are small (38%, single building locations) and very large (62%, multiple buildings). The gross floor area and total surface area range respectively from 200 to 3,200,000 m^2 and 80 to 5,300,000 m^2. This wide range is also expressed in the standard deviation of 491,000 m^2 for gross floor area and 758,700 m^2 for the total site. The average gross floor area of the sample is 163.700 m^2 and the total site area averages on 364,400 m^2. These metrics suggest that the larger city/region-style locations proposed by Zhang (2002) are not part of the sample, while the incubator-style locations are present.

Table 4 shows the values for laboratories, incubators, pilot rooms, clean rooms and other R&D facilities. Laboratory facilities are on average the largest facility provided, followed by 'other R&D-related facilities'. Other R&D facilities frequently mentioned are access to university facilities, industrial-related (workshops, Fablab), and animal research facilities.

Table 4: Surface R&D facilities (m²)

	Laboratories	Incubators	Pilot rooms	Clean rooms	Other R&D facilities
Minimum	28	25	20	40	50
Maximum	200,000	50,000	10,000	15,000	100,000
Mean	10,700	3,700	530	660	6,170
Standard deviation	29,700	7,650	1,500	2,000	15,200
Missing values	6	5	7	7	8

Respondents were asked whether the different R&D facilities were intended for shared usage in general. Some mention that usage of R&D facilities varies per location (i.e. in-house and shared, access to university facilities, etc.). The two light grey bars in figure 1 show the presence of the R&D facilities and whether they are for shared use. The majority of cases (95%) have an incubator, while a large portion of these incubators (65%) are for shared use and the more specialised facilities (clean rooms and pilot rooms) are present and shared at half of the cases.

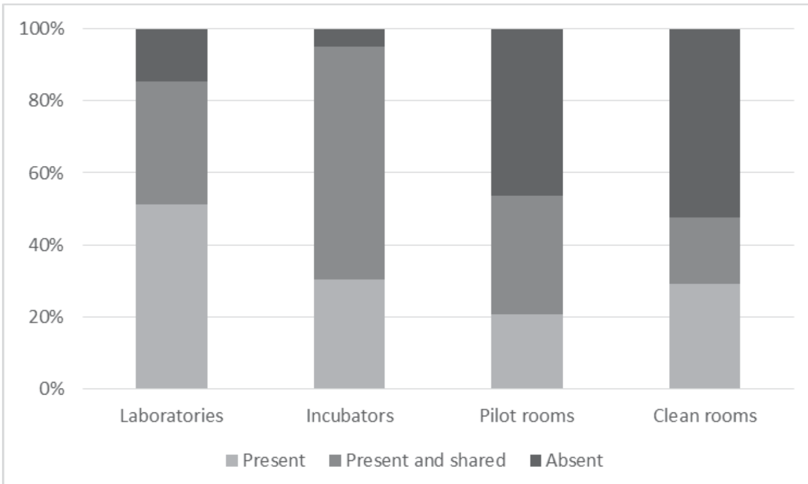

Figure 1: Presence, absence and shared usage of R&D facilities

Table 5 shows the facilities and services present within the sample. The differences between working facilities are not large with the only exception of "exhibition rooms" that are present at half of the parks. Other work-related facilities that were mentioned by respondents were co-working spaces/flex offices. Leisure and other facilities show a larger variety among cases. The offering among larger SPs with regard to these two types of facilities is far more diverse than at smaller location. In some cases, additional leisure facilities were present at the location or in proximity, such as a theatre, art, museum, and sauna/wellness centre. From the 15 cases that provided residential housing, nine locations were partly or completely owned by universities. The most occurring services provided are "networking events" (92% of the cases), "training" (85%), and "consultancy" (74%).

Table 5: Presence of facilities and services (N = 82)

Working facilities		Leisure facilities		Other facilities		Services	
Meeting rooms	100%	Sport centres	35%	Cleaning and maintenance	60%	Networking events	91%
Conference rooms	91%	Sporting grounds	27%	Safety and security	52%	Training	85%
Eating facilities	89%	Hotel	20%	Shops (food)	37%	Consultancy	74%
Library	80%	Cinema	7%	Child care	35%	Venture capital access	66%
Auditorium	80%			Medical	23%	Information access	63%
Exhibition rooms	49%			Banking	22%	Management support	60%
				Residential housing	18%	Administrative	59%
				Shops (non-food)	17%	Marketing	52%
				Travel agency	10%	Accounting	41%
						Graphical design	24%

4.2 Results non-physical characteristics

The average age of the locations is 14,5 years. With the years since establishment ranging from 2 to 33 years (standard deviation 9,3). This suggests that the older cases were established in the growth era of SPs in Europe (Storey and Tether, 1998). The majority of cases (26%) is owned by a public entity. The second largest group are those with a public-private ownership (24%). Together university-owned and privately-owned SPs compose 15% of the sample. Both university-public and triple helix partnerships cover 10% of the sample. University-private ownership is only found at one location. When looking at all cases with a university ownership affiliation this group accumulates to 36%.

The technology sector most frequently present is the "biotech, life sciences and medtech" group, followed closely by "computer-related and electronics" (see table 6). Other sector groups mentioned by respondents that are not included in the original list are: (creative) multi-media design, ICT-based tourism, and sports technology. In total respondents chose 318 technology sectors groups, which averages to four technology sectors per case. 15% of the cases have a single focus, 10 of which are focusing solely on the biotechnology group. Cases with a high sectoral focus (targeting 2 or 3 sector groups) and a medium sectoral focus (4 different groups) respectively cover 24% and 23% of the sample. However, the majority of 38% has a low sectoral focus, targeting five or more sector groups. This suggest that SPs target a wider range of high-tech sectors.

Table 6: Technology sector groups covered (% of N =82)

Technology sector groups	
Biotechnology and life sciences, chemistry and chemicals, food sciences, medtech and pharmaceuticals	71%
Computer sciences, internet technologies, ICT and communications, software engineering	66%
Electronics, micro- and nanotechnology, optics, robotics and automation, sensors and instrumentation	61%
Energy and environmental technology, nuclear sciences	50%
Industrial (civil and construction engineering, industrial manufacturing, mechatronics, new materials	34%
Aerospace, space technologies, transportation technologies	28%
Agriculture and forestry, earth and mineralogy sciences, metrology services	7%
No specific sector group	1%

With regard to SP objectives, respondents were asked to distribute 100 points among six classic SP objectives, based on importance. On average the objective "creation and growth of new firms" received the largest share of points (31), followed by "technology and knowledge transfer" (19), "regional development" (17), and "knowledge creation" (15). The more traditional objectives, "local benefits" (11) and "industrial rejuvenation" (7) receive considerable less points across all cases.

The management function deployed on site varies among four models: "on-site management company" is most frequent with 65% of the cases, "single on-site manager" with 24%, "informal teams", where there is no explicitly assigned organising management, is present at 9% of the cases, and only 2% have "no management function of any kind" (informal or formal). The manner in which networking among residents on-site is conceived is quite uniform with 89% stating that networking is actively promoted by the site management, while 9% state that this is not one of the core priorities of the management, and 2% state that residents network on their own initiative.

Table 7 shows the number of resident organisations and the different types of organisations present at the SPs. The sample shows a large group with a smaller number of resident organisations, 35% of the cases have less than 50 resident organisations. This is in line with the relatively large share of smaller locations addressed earlier.

Table 7: Number of resident organisations and present organisation types

Number of organisations	N=82	**Start-up firms**	**98%**	**Higher educational institutions (HEI)**	**66%**
Less than 50	35%	NTBF	90%	University	60%
Between 50 and 100	22%	Non-NTBF	54%	Other HEI	40%
Between 100 and 200	23%	University spin-off	82%	**Research institutes**	**65%**
Between 200 and 400	13%	Corporate spin-off	62%	Public research institutions	48%
Between 400 and 600	5%	**SME and multinationals**	**88%**	Private research institution	41%
More than 1000	1%	Small-medium enterprises	85%	**Service companies**	**61%**
		Multi-national companies	67%		

Start-up firms are present at 98% of the cases. This includes new (non)technology-based firms, corporate or university spin-offs. Small, medium enterprises, and multinationals are present at almost 90% of the cases. Higher educational institutions, research institutions, and service companies are relative to the other two resident types less present at all cases.

Tenants for the location are mainly selected on “their focus on R&D” (82%) and “technological orientation” (72%). Other less chosen selection criteria are “commitment with academics” (39%), “attract funding for research” (37%), and “quality of past research” (27%). Respondents were free to include additional criteria, these often range from: eagerness to collaborate, team quality, (international) business potential, and the potential to create high value jobs. Besides the traditional selection criteria stated by Link and Link (2003), SPs are also critical on the human capital and commercial capabilities of tenants.

5. Conclusion and limitations

This study shows an explorative view of SP resourcing in Europe. The literature review on park characteristics and subsequent field research with 82 cases provide insights for the current SP context. The characterization of SPs adds to existing theory.

From a physical perspective, in accordance with Lamperti et al (2017), incubators are present at almost all locations. This is also reflected by the objective that is deemed most important by SP managers, namely “creation and growth of new firms”. In addition, the most provided service on SPs are “networking events”. This underscores that SPs are aimed at supporting business development with appropriate facilities and services. In contrast, research institutes are only present at 66% of the locations, which suggests that there are variations among SPs. Furthermore, the majority of the cases are located either in a city or in proximity to an urban area. This is in accordance to the global trend of urbanization; suggesting that SPs are developed close to human talent required for conducting knowledge-intensive activities.

Looking at the non-physical features we show that in contrast to Link and Link (2003), only 36% of the 82 cases are completely or partly owned by universities. This indicates that for the European context university affiliation is not a prerequisite for SP characterization. In addition, this paper adds to the work of these authors through complementing their tenant selection criteria with requirements for team skills and commercial capabilities. As reported by various authors (e.g. Siegel et al, 2003; Capello and Morrison, 2009), SPs in Europe tend to have some form of management function and networking on a majority of the locations (89%) is actively stimulated by this entity. Furthermore, Van Winden and Carvalho (2015) state that accessibility to knowledge is key to managing knowledge locations. The means to achieve this is also reflected in the sample: management of the resident composition through selection and promoting networking between residents in order to transfer knowledge.

By no means is this attempt conclusive for the European situation. Although the international sample is uncommon in SP research, the sample is still relatively small, and the response rate among countries may seem biased, which limits the generalizability of the results. Further in-depth case studies are required to gain even more insight. However, the characteristics revealed in this study provide a clear outline of what a SP represents. This study provides academics and practitioners with a better understanding of SPs and may advance the debate through taking into account the differences among SPs.

Differences among SP characteristics may contribute to the three KM outcomes: knowledge creation, retention, and transfer. These infrastructures provide shelter to various knowledge producers (i.e. universities, research institutions, firms). When these knowledge producers stay at the SP location, knowledge could be retained, and even transferred between organisations. The proximity between the organisations, shared usage of facilities and support services are ways to transfer knowledge. Lastly, SPs are characterized by their ability to commercialize knowledge (i.e. presence of incubators and spin-offs, venture capital access, financial and marketing services). Future research is needed to evaluate the impact of these characteristics on the actual KM outcomes.

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