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Measuring the success of science parks by means of a performance measurement system

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The impact of STPs and AOIs

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Measuring the success of science parks by means of a performance measurement system

Executive Summary

This paper provides an overview of a PhD project. The research was carried out between 2010 and 2014. The purpose of this research was to understand how to define success (organisational goals) and consequently how to measure multi-dimensional performance using a theory grounded performance measurement system (PMS) in a knowledge intensive and multi-owner organisation, being a science park (SP). Moreover, it identifies a gap between what is already measured and what SPs consider as being the most important to measure. Furthermore, it proposes a common methodology which allows for customisation of performance measurement tool according to the ownership models of SPs and their strategic priorities. The research supports the hypothesis that the ownership model of a SP is a key determinant of its appropriate performance measures.
The empirical part of this research consisted of two steps, first an exploratory part with action research and second, a validation stage with survey research.

CONTENTS

Introduction

The literature assessing SPs' success focuses mainly on evaluating on-park companies' performance rather than SPs' performance as independent organisations (see the literature summary table in annex 1). Most of the academics used the matched sample approach to assess the success of SPs which according to Charles and Uyarra (2010) is relatively methodologically straightforward. Nosratabadi et al. (2011) demonstrate that measuring the performance of SPs is a complex task and as they have evolved, it has become even more difficult. The uniqueness of the SPs and their specicific characteristics make the performance measurement within the parks a complex exercise.

In addition, there has been confusion within the literature and although many researchers talk about performance measurement of parks, in reality, they carry out an evaluation exercise which is a one-off analysis and not a continuous exercise carried out in collaboration with the management of the park (EC, 2014).

Recently, mainly due to fragile economic conditions especially in Europe, SPs have had to prove how successful they have been. They have to demonstrate to investors and funders, either public or private, their ability to be financially sustainable in the current economic climate.

Furthermore, in the last 15 years the public sector, following the example of the private sector, became increasingly interested in measuring its own performance and that of organisations in which they have a financial interest (Thomas, 2006). Therefore, the public bodies' expenditure and consequently activities need to be transparent and effective.

Ad-hoc performance measures to assess performance of SPs have been used by the SPs themselves. They used rather traditional indicators or operational indicators paying limited attention to the role of knowledge within SPs (Hansson, 2004). Indicators related to internal knowledge production within SPs have not been widely used despite the growing focus on knowledge in the new economy. A few workshops and conferences were organised by the International Association of Science Parks (IASP) and/or individual SPs around the subject of performance measurement, however no common methodology to arrive at what to measure and how to measure has been developed. Nevertheless, there seems to be significant advantages in applying a common approach to performance measurement across international SP sector community. For example, Luger and Dabrowska (2012) discuss developing metrics of success to try to monetise the value of parks to the regional economy whilst Davies (2013) suggests using a PMS to measure parks' success.

A range of performance management systems has been developed over the last 30 years. All of them have strengths and weaknesses (Striteska and Spickova, 2012; Garengo et al., 2005). In general, the developed performance measurement models, although they have a clear and extensive theoretical background, do not offer solutions or guidance on how an organisation should design its own PMS. They do not point out what and how to measure and furthermore do not propose guidelines for practical implementation at the operational level (Garengo et al., 2005). Moreover, the existing PMSs are too general, they are not sector specific. It is evident that each sector has got different characteristics and context and therefore different aspects of business should be measured. The topic of performance measurement is still being explored and there is an obvious need to investigate how theoretical models can be translated and tailored to match the unique measurement needs of companies and other organisational forms (Striteska and Spickova, 2012).

This paper encapsulates the outcomes of the action and survey research carried out between 2010 and 2014. The first part of the research (action research) helped develop a better understanding of what a successful SP means to public, private and university owners as well as client companies, i.e. what they consider as success factors for SPs and how to measure progress towards these success factors. The outcome of the participatory work (search conference) was an initial PMS which was tested and completed at the survey research stage.

Furthermore, the survey research findings demonstrate that there is a significant discrepancy between what the SPs already measure (what indicators they already use) and what they think is important for them to measure (what they selected as KPIs for their organisations).

The research offers a distinct approach (a generic performance measurement system for SPs) on how to measure multi-dimensional performance using a theory grounded PMS in a knowledge intensive and multi-owner organisation, being a SP. Moreover, it proposes a common methodology which will allow for customisation of performance measurement tool according to the ownership models of SPs and their strategic priorities.

The research supports the hypothesis that the ownership model of a SP is a key determinant of its appropriate performance measures.

The first part of this paper will discuss the strengths and weaknesses of the existing theoretical frameworks (PMSs). Then, it will give an overview of the outcomes of the action research. The last part will discuss the findings of the survey research and will introduce the final PMS for SPs.

1. Analysis of PMSs

According to EC (2014) performance measurement is an ongoing process of monitoring how well or how poorly the organisation is doing in achieving its pre-established goals. It involves continuous collection of the data related to:

- type of activities/resources used to produce outputs and outcomes (input)

- direct and immediate result of an activity (output)

- medium-term or long-terms achievements that result from outputs (outcome/impact)

Performance measurement revolution began in the 1980s and resulted in the development of new conceptual performance measurement frameworks such as balanced scorecard, performance prism, SMART performance pyramid, etc. (see table 1 below).

Taticchi et al. (2010) carried out a frequency of citation analysis of publications between 1970 and 2008. Their work can be considered as an update done by Neely in 2005. Kaplan and Norton and the balanced scorecard came on the first position. This research outcome is not surprising. In 2015 Savsar claims that balanced scorecard is the most commonly used performance measurement tool. Neely (2005) claims that between 30 and 60 percent of firms have adopted balanced scorecard in the US. This citation analysis does take into account titles of published papers and not names of performance measurement frameworks. Moreover, this analysis was done over the time period of 38 years therefore it is likely that older papers received a bigger chance to be cited more than recent papers which talk about newer frameworks.

Based on the literature indications a weakness and strength analysis of the most popular PMS is proposed below:

PMS	Strenghts	Weaknesses
Performance measurement matrix **Keegan et al. (1989)**	- Shows what the measures could look like - customer related measures are included on the framework - gives some information about areas of performance to consider when designing a PMS, helps define goals - simple and flexible - helps define strategy	- Does not include all dimensions of company's performance such as customers dimension or human resources - does not provide a truly balanced view of performance - is not clear how to implement the model - does not provide clear guidelines how to develop adequate measures - designed for manufacturing industries
Results and determinants **Fitzgerald et al. (1991)**	- links results with determinants - designed for service industries - Talks about capturing intangibility of service - talks about innovation as one of the determinants of company's success which generates impact on results (financial and market performance)	- does not provide clear guidelines how to develop a complete PMS with adequate measures - no mention of links between strategy and performance - not considering interests of stakeholders
Balanced scorecard **Kaplan and Norton (1992)**	- helps formulate a clear vision, translates strategy into targets - is a transparent multi-disciplinary and multi-dimentional communication and monitoring tool - gives a clear view on interconnection between company's success and performance drivers - includes financial and non-financial dimensions of the business - looks at performance from different stakeholders' perspectives (customers and shareholders) - It is a self-assessment tool at company level - links different dimensions of business performance together	- does not provide information how to benchmark the results - difficult benchmarking - lack of guidelines which measures to use for each perspective and how to manage the process - some areas are difficult to quantify - complex tool needing commitment within an organisation towards accepting it - not considering interests of all stakeholders (lack of suppliers, competitors, HR, employees, regulators and community)
Business excellence model **European Foundation for Quality Management (EFQM) (2001)**	- is a comprehensive, self-assessment tool - identifies strong and weak points of the company - encourages systematic performance measurement - allows sharing of best practices with other businesses - indicates measuring performance in the area of innovation and partnership development - indicates public responsibility as one of the drivers of company's performance and impact on society as a result of company's operations	- no balance within dimensions - criteria are general - is not directly linked to company's strategy (not a strategic management tool) - does not provide clear guidelines how to develop and manage an adequate PMS
SMART performance pyramid **Cross and Lynch (1998/1999)**	- indicates to measure performance in the area of quality - encourages to link overall business objectives with operational objectives - is a strategic management tool - highlights customers' importance and quality of service provided - points to measure 'waste'- links company's performance with corporate social responsibility with the aim to reduce waste - recognises hierarchical levels that exist within an organisation - recognises the importance of human resources - talks about internal effectiveness and external efficiency	- Aimed at manufacturing organisations - does not provide guidelines how to select key performance indicators - does not give details about form of measures - terms are so broad that it is difficult to put in to practice. - customers and employees are main stakeholders considered in the framework
Performance prism **Neely et al. (2002)**	- introduces new groups of stakeholders such as employees, suppliers, alliance partners or intermediaries who have impact on company's performance - talks about stakeholders' contribution to company's performance - can be adapted to profit and non-profit organisations, small or big organisations - highlights importance of human resources and technological capability - helps define strategy	- lack of guidelines how to implement performance measures - no link between the results and drivers - not clear what some groups of stakeholders, especially competitors, can contribute to the company's performance

Table 1. Strengths and weaknesses table, Author: Dabrowska

All of the analysed frameworks address the limitations of traditional performance measures which were mostly financial based on traditional accounting. Financial dimension, although it is still an important indication of company's performance and growth has been completed with other non-financial dimensions. The discussed frameworks indicate that organisation's performance is to be measured using numerous parameters in a more balanced and multi-dimensional way. This holistic approach is essential to assess overall business health and organisation's success (Neely et al., 2002).

For both, performance prism and balanced scorecard frameworks, focus on stakeholders' needs is essential. Neely (2005) even talks about a reciprocal relationship between the organisation and the stakeholders which is a unique approach that has not been applied before 2003.

Measuring business performance through innovation has been shown in business excellence model and performance measurement matrix.

Interestingly, measuring performance in the area of social responsibility comes to light in business excellence model and performance pyramid.

All measurement frameworks, except performance prism, fail to recognise the reciprocal relationship between the stakeholder and the organisation (Neely et al., 2002). Amongst mentioned stakeholders, Nelly et al. (2002) list suppliers, communities, customers, investors, employees, regulators and intermediaries. It is not difficult to define employees' or investors' contributions, however contributions from competitors are not easy to determine.

Balanced scorecard and performance pyramid are two excellent examples of strategically driven performance measurement frameworks. Companies can apply them to identify goals, objectives and communicate strategies (Striteska and Spickova, 2012).

In contrast, non-prescriptive business excellence framework is more general.

Most of the frameworks developed after balanced scorecard tried to built on its strengths and address its shortcomings (Striteska and Spickova, 2012) as well as adapt to the changing contexts.

Based on the analysis above, there is no perfect PMS. They all have strengths and weaknesses. They all have been developed in different contexts, some were designed for specific industries (e.g. Smart pyramid or performance measurement matrix are aimed at manufacturing firms, results and determinants framework is aimed at service industry). Dumond (1994) acknowledges that there is no unanimous agreement on components and characteristics of PMSs. Meyer (2002) says that the explanation why performance management systems are so challenging is the fact that it is not clear what we want to measure can be measured.

Therefore, the biggest limitation of all of the frameworks is the selection and implementation of the performance measures. The developed frameworks, although they have strong theoretical backgrounds, they do not give clear guidance on how to design a dedicated PMS. They rather guide which business performance areas/perspectives should be considered while developing a framework but not what and how to measure at operational level Garengo et al. (2005). There is a need for frameworks that will offer guidelines for practical implementation (Brem et al., 2008).

In addition, most of the frameworks offered by academics are too general and too universal, aimed at big companies and several sectors at the same time. The exception was results and determinants framework which was explicitly designed for service sector. However, Fitzgerald et al. (2001), recognise the diversity within service sector companies and therefore different measures should be applied for each of them.

It is obvious that ICT sector companies, bio-sector companies or libraries will have different performance measurement needs than a SP. One size does not fit all. Therefore, more sector focused PMSs are needed.

Moreover, it is evident that that contexts as well as companies' strategies may change. Consequently, there is a need for a dynamic and flexible system that will smoothly adapt to the

changing external and internal contexts and company's objectives (Bitici et al., 2000; Neely et al., 2005; Striteska and Spickova, 2012).

2. Action research

In October 2010, an IASP European Division workshop (search conference[1]) was organised in Manchester, UK with the objective to understand what SP success means to university, public sector, private sector and companies on the park and how to measure progress towards this success (in other words how well or how poorly a SP is doing in achieving its pre-established goals - performance management).

SPs are often multi-owner organisations and therefore the definition of success for a SP changes according to its ownership structure. Luger and Goldstein (1991) say that in order to define success one must identify goals and objectives against which to measure the success.

Primary stakeholders[2] (owners) who define goals and objectives for SPs have different expectations (due to the nature of their organisations) and consequently the objectives vary from one SP to another.

Davies (2013b) points out that SPs and areas of innovation should constantly measure progress towards their strategic goals. She indicates that SPs or so called 'areas of innovation' should monitor progress towards success by means of a PMS.

Therefore, first it was essential to understand and agree on the goals that were most important to SPs and then assess their performance against the agreed goals using a set of performance indicators (Dabrowska, 2011).

2.1. Outcomes of the action research

The action research (carried out at the search conference/workshop in Manchester in 2010 and post conference meetings in Bilbao and Berlin in 2011) led to identify organisational goals based on the needs (expectations) of the primary stakeholders and the on-park companies, i.e. SP customers. They were presented in form of success factors.

In the first place, the proposed PMS was inspired by the balanced scorecard approach, the most widely used, clear and simple framework (Neely et al., 2002). Kaplan and Norton (1992) integrated four perspectives into their balanced scorecard, i.e.; financial perspective, customer perspective, internal business perspective and innovation and learning perspective. They, for the first time, introduced a multi-dimensional, balanced, multi-stakeholder and strategy based approach towards performance measurement. The balanced scorecard has developed over the years and evolved from a measurement tool to a strategic performance management (Neely, 2002).

Different PMS include different dimentions to consider when measuring business performance, e.g. partnerships, commercial, collaboration, cooperation, innovation, people, etc.. The EFQM model indicates to assess customers' results to demonstrate the real business performance.

[1] Search conference is an action research data collection tool introduced by Trist and Emery in 1959

[2] For the purpose of this research SP stakeholders are divided into two groups according to Thomlinson's definition (1992), i.e. primary and secondary stakeholders.
According to Thomlinson, **primary stakeholders** have formal, official or contractual relationship and a direct influence on the organisation. In contrast, secondary stakeholders are not directly involved or engaged in the company's economic activities but are able to generate influence or are affected by the organisation's operations.

Similarly, Bourne et al. (2003) demonstrate that to assess performance we need to measure the impact of actions on the stakeholders.

At the meeting in Manchester, eight most important success factors (called also strategic objectives or organisational goals) were identified to match primary stakeholders' and customers needs (expectations). They are presented on the figure below in the green boxes. Jones (2011) calls success factors strategic themes and indicates that strategy themes help divide the strategy into separate areas of attention and when necessary new perspectives need to be developed.

Moreover, the conference participants identified indicators to measure progress towards success factors. Selected performance indicators (action research findings) have been clustered in order to identify adequate performance perspectives. Six performance perspectives have been found as a result of the search conference in Manchester. One additional performance perspective has been identified as a result of the post conference process (workshop in Berlin in 2011).

The figure below (Figure 1.) represents a performance measurement strategy for SPs which was developed as a result of the action research. It summarises the findings of the action research including success factors and performance perspectives from which SPs' performance could be measured.

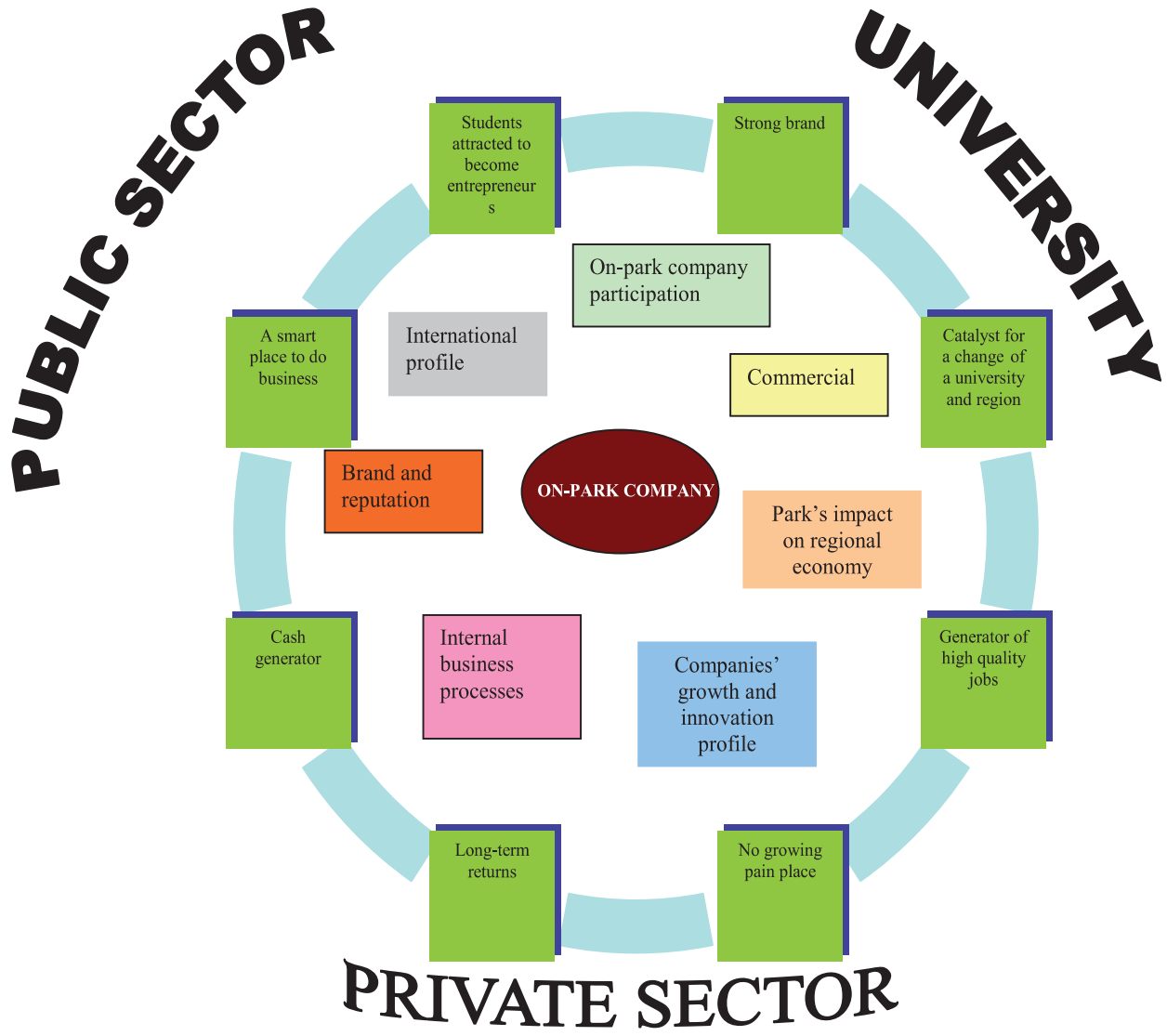

Figure 1. Performance measurement strategy for SPs

2.2. Initial PMS for SPs

Based on the outcomes of the action research, theoretical indications and performance measurement strategy for SP an initial PMS for SPs was designed (see appendix 2). It is divided into seven performance perspectives (named also performance areas or performance categories or performance dimensions) to cover all aspects of the SP's performance: commercial, tenant participation, companies' growth and innovation profile, international profile, brand and reputation, internal business processes, the park's impact on regional economy. 'Commercial' and 'internal business processes perspective' reflect perspectives suggested by Kaplan and Norton (1991). The commercial perspective will measure financial sustainability required from SPs by Allen (2007) and Luger and Goldstein (1991) but also required by the primary stakeholders. The remaining perspectives have been added as suggested by Jones (2011) to reflect other strategic priorities. The tool will provide a multi-dimensional and balanced picture (Kaplan and Norton, 1992, Neely et al. 2005) of the overall business performance of SPs.

Perspectives such as 'companies' growth and innovation profile' or 'tenant participation', although assess customers' results will provide an indication of the park's business performance (EFQM, 2001). It will also help demonstrate the impact of the SP's actions (Bourne et. al, 2003). The indicators will provide input as well as output and outcome/impact evidence (in accordance with the EC definition of input, output and outcome/impact) which will allow to substantiate the value of SPs' services, especially in the area of innovation activity. The evidence of the value of this type of activity is required by the primary stakeholders, especially the private sector shareholders e.g. to justify costs.

As mentiond above, due to the nature of their organisations, SP primary stakeholders have different expectations (sometimes even contradictory) from SPs and therefore strategic objectives vary. Lebas (1995) and Kaplan and Norton (1992) claim that PMS can use complementary as well as contradictory indicators. Therefore, to measure progress towards defined success factors a comprehensive set of indicators has been proposed (appendix 2). However, not all indicators should and can be applied to all SPs. As performance indicators measure behaviour of a business process, KPIs are the key measures which determine stakeholder value and clearly match strategic objectives (Kennas, 2014).

As the SP success value varies for shareholders, the selection of KPIs will also vary. Therefore, it is assumed that different ownership model SPs select different performance indicators to measure progress towards their success. This hypothesis was tested through survey research (validation stage) and the initial PMS for SPs was verified.

3. Survey research

The purpose of the survey research was to verify and complete the outcomes of the action research (qualitative research). A survey research (quantitative research) was used to complement the findings of the qualitative research. Mixed research methods (triangulation) were used to allow deeper analysis, bring more robust findings more and a holistic view on the investigated phenomenon.

3.1. The questionnaire and sample characteristics

The questionnaire was designed by the researcher and the questions were based on the outcomes of the action research and consequently on the initial PMS for SPs.

The questionnaire was distributed to approximately 220 SPs and the data were collected between February and October 2014 using a cloud-based online survey software. The database was cleaned up and validated to avoid errors due to poor completion of the questionnaire or data importation process.

Once the database was cleaned up, the researcher entered the data into statistical software (Stata13). 60 SPs responded to the questionnaire. The sample represents 27.3% of the universe (IASP full members).

The sample consisted of 60 SPs from 35 countries across 5 continents (Europe: 44 SPs from 22 countries, Asia: 8 SPs from 4 countries, North America: 3 SPs from 3 countries, South America: 3 SPs from 3 countries and Africa: 2 SPs from 2 countries).

As seen on the pie chart below (Figure 2) seven ownership models of the SPs have been identified based on the questionnaire answers. The models are as follows: university SPs which represent 18% of the whole sample, public SPs which similarly represent 18% of the sample, private SPs which represent 12% of the sample, university-public SPs which represent 16%, triple helix (public-private-university) SPs represent 16% of the sample, university-private SPs and public-private SPs represent each 10% of the whole sample.

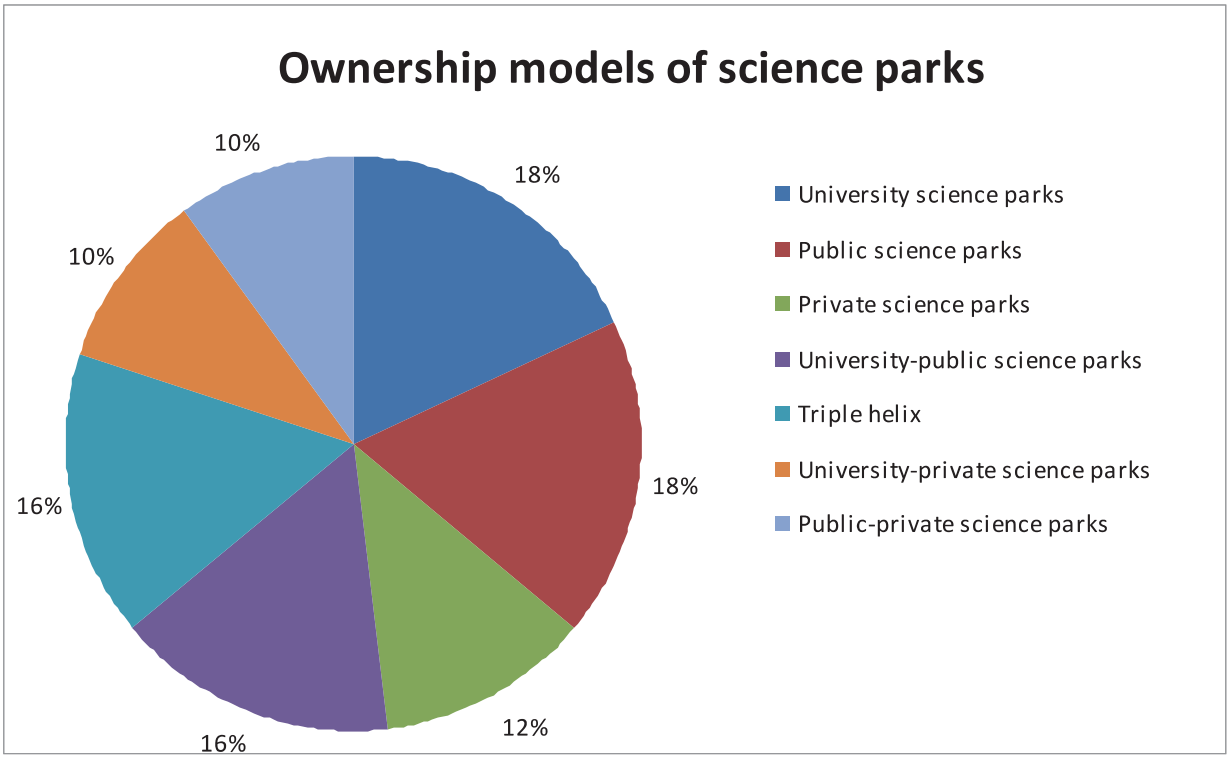

Figure 2. The ownership models of SPs

The questionnaire data shows that there is no preferred ownership model that is the most popular within the SP movement.

All three sectors (public, private and academia) are involved in different configurations in the SP ownership structure. The last two ownership types i.e. university-private and university-public seem to be the least popular within the examined set of the SPs.

Mixed-ownership structures are quite common for SPs. The risks and expertise can be shared as well as benefits distributed within the different sectors (academia, public and private sectors). 52% of the analysed SPs have more than one organisation (either public sector or/and private sector, and/or university) involved in the ownership structure.

Due to the nature of their organisations they all have different agendas that influence parks' strategic priorities and therefore the selection of KPIs will vary. A one-fits-all framework for all different types of SPs is not an adequate solution. SPs need to have flexibility to select their KPIs in accordance with their organisational goals aligned with their ownership structures.

3.2. Findings from the questionnaire

As disussed in the previous sections the findings of the action research allowed to identify seven areas/perspectives in which to measure performance within SPs, i.e. commercial performance, tenant involvement in the park activities, companies' growth and innovation profile, brand and reputation, internal business processes, impact on the economy. For each perspective performance indicators have been identified as a result of participative enquiry (Collis and Hussey, 2003). Based on the empirical evidence an initial PMS has been designed.

The survey research was selected to validate the initial framework and hypothesis formulated at the exploratory stage as follows 'the ownership model of a SP is a key determinant of its appropriate performance measures'.

The questionnaire allowed the researcher to see which performance areas are important to measure for different types of SPs and what indicators they already use and what they think is key for them to measure (selection of KPIs).

For SPs where university is the owner or co-owner (except triple helix SPs) 'companies' growth and innovation profile' as well as 'tenant involvement in park activities' are the most important areas of performance. For SPs where the public sector is involved (public, triple helix SPs, public private SPs) 'impact on regional economy' is the most important area of performance to measure. Public-private SPs, although rank the 'impact on regional economy' as the most important area of performance to measure, the 'commercial performance' is selected as the second important area of performance. This shows the balance between the public sector interests/requirements and the private sector interests/requirements. It also demonstrates that SPs have multiple-goal nature and that KPIs may be occasionally contradictory (Lebas, 1995; Kaplan and Norton, 1992).

In addition, the private sector SPs rank 'commercial performance' as the most important to measure however Skinner (1974) indicates that traditional financial measures lack strategic focus. 'Tenant involvement in the park activities', as well as 'international profile' are the least important to measure for this type of SPs.

The presence of the private sector in the ownership structure of SPs has been more visible recently. They (private sector SPs and public-private SPs) do not show as much interest in innovation activity as other ownership models of SPs. Based on the empirical evidence, it can be said that the increased presence of the private sector in the ownership structures may represent a threat for SPs' image and may result in decrease of innovation activity or other added-value services which are most recognisable trademarks of SPs (IASP, 2015).

Therefore, it is even more important to use a PMS for SPs which is considered as a communication tool at horizontal as well as at vertical levels (Bourne et al., 2003 and Neely et al. 2002). It will substantiate the value of innovation services in language that private sector will understand. For instance, one of the performance indicators selected by the delegates in Berlin (action research) was 'percentage of enquiries as a result of networking/innovation activity' (one of the outcome/impact indocators).

This type of indicator shows the commercial value of the innovation services to the private sector and justifies the staff involvement in this type of activities, time and money spent.

Moreover, innovation services give SPs a competitive advantage over traditional property management companies to the extend to be able to charge a premium rent.

The least popular area of SPs' performance is international profile. Dabrowska (2009) demonstrates that SPs have become tools in delivering regional internationalisation startegies. Their expertise and reputation is used to attract and retain quality inward investment. The lack of interest in international activities may result in decrease of inward investment companies coming to a park, decrease of international commercial and/or collaboration opportunities for on-park companies, decrease of continuous learning and improvement (if not attending for instance IASP meetings to share best practice), one of the key characteristics of knowledge organisations (Hansson, 2007).

The survey research shows that private sector SPs, in particular, pay very little attention to measuring international profile of SPs. As the presence of the private sector within the ownership structures increases, the SPs may get less involved in providing international support. Again, this represents a treat for SPs and may have a negative impact on the SP brand.

Having a comprehensive PMS for SPs may also help understand the value of international activities to the SPs' owners. It can translate intangible activities into tangible evidence.

It needs to be highlighted that the questionnaire analysis shows a significant gap between what SPs already measure (performance indicators) and what they select as their five KPIs for each performance area.

To summarise, one of the most significant gaps between what is measured and what should be measured can be observed while looking at 'tenant involvement in park activities' perspective. SPs tend to measure links that companies have with a university or other knowledge-based organisation (current situation – 53% already use this indicator). However they select as KPI number one 'links to universities or other knowledge-based organisations as a result of SP interventions'. This indicator, although so popular is significantly less used by the SPs (34% of the parks already use it). Similarly, only 28% of the SPs measure 'inter-company trading as a result of SP interventions', however it was selected as KPI number two. 'Inter-company trading' indicator was not selected as a KPI by the whole sample although 31% of the SPs already use it.

Moreover, only 21% of the SPs measure 'additional business or funding raised by companies as a result of SP interventions' however it was selected as KPI number three. 'Additional business or funding raised by companies' was not selected as a KPI although it is currently used by 30% of the SPs.

This shows that the SPs want to measure the outcome/impact of their innovation activity rather than measure general performance of on-park companies. So far most of the studies (see table in annex 1) concentrated on measuring on-park companies' performance to show the success or failure of SPs (Lindelöf and Löfsten, 2002; Colombo and Delmastro, 2002). The research demonstrates that there has been a growing interest within the SP sector in measuring SP performance as an individual business rather than through achievements of its on-park companies.

Other mostly observable gaps between what SPs measure and want to measure are as follows:

- Only 14% of the SPs use 'investment returns' indicator to measure commercial performance however the parks selected it as one of the KPIs
- 45% of the SPs use percentage of companies investing in R&D to measure 'companies' growth and innovation profile', however it was selected as one of the KPIs
- 44% of the SPs use 'number of products/services developed by on-park companies' to measure 'companies' growth and innovation profile', however it was selected as one of the KPIs
- 49% of the SPs use 'number of companies in the SP network' to assess 'brand and reputation' performance however it was selected as KPI number two
- Only 8% of the the sample use 'number of companies whose technologies have been applied in other countries and generate considerable impact outside the country of origin' to measure international profile. It was selected as one of the KPIs
- Only 4% of the SPs use 'number of requests to take part in studies and benchmarking exercises' to measure international profile. It was selected as one of KPIs

The discrepancy between current indicators and selected KPIs may be caused by inadequate selection of performance indicators and lack of a common methodology how to select performance indicators. Garengo et al. (2005) as well as Striteska and Spickova (2012) say that there is a lack of guidelines on measures to be used to assess different dimensions of the business' performance and the lack of information on practical implementation of measures. By proposing a generic PMS for SPs (matrix with performance indicators for each performance

perspective) and a common methodology that will enable a park to develop a customised PMS the researcher tried to overcome the limitations existing in the literature related to the lack of guidelines on practical implementation of PMSs

Another reason for inadequate selection of performance measures may be a lack of clear strategic objectives for a SP. This may be due to the fact that SPs are often multi-stakeholder organisations and the communication between the shareholders or the shareholders and the management may not be efficient. Consequently, the strategy and objectives are not clear. Another reason may be that the owners are not committed to the SP and the communication is not efficient. The proposed methodology invites the owners of a SP to work closely with the managers to define and agree on the strategic objectives which will help select adequate KPIs. Ketelhohn (1998) claims that KPIs enhance the implementation and acceptance of a business strategy.

Developing a customised PMS will help SPs to communicate their objectives in a clear way and their achievements in a more tangible way.

Besides, Neely et al. (2002) talk about stakeholders' contributions to companies' performance. The participatory process of developing a clear strategy for a SP may give the shareholders an opportunity to learn about the park, understand its strengths and weaknesses and consequently may commit to support the business or the companies on the park. It enhances two way collaboration between shareholders and the SPs, i.e. the park will contribute to its shareholders but the shareholders will also contribute to the SP.

The action research demonstrated that SPs' success means different things to different primary stakeholders. In addition, the questionnaire analysis (survey research) showed that SP managers put different emphasis on selected performance areas/perspectives and selected different performance indicators to assess performance in those areas. It matches Defourny et al.'s (2006) observation that multi-stakeholder organisations have multiple-goal nature and their goals may alter depending on stakeholders.

The empirical evidence also confirms that setting up a one-fits-all PMS would not be an appropriate solution for SPs and that the ownership model of a SP is a key determinant of its appropriate performance measures. Therefore, the final PMS for SPs was designed to be a flexible tool that reflects multi-owners' requirements. A common methodology will enable SPs to develop customised PMSs i.e. select KPIs according to strategic objectives of individual SPs.

The next section presents the final, generic PMS for SPs and a proposed methodology to develop customised PMSs.

3.3. Final framework and methodology to customise PMS for individual SPs

The final generic framework consists of seven performance areas called performance categories/performance perspectives. They represent multi-dimensional and multi-owner character of the SPs. Each perspective consists of several performance indicators to choose from. The proposed indicators include input indicators, output and outcome/impact indicators. The outcome/impact indicators in particular will substantiate the value of the intangible knowledge-based activity of the SPs which make them unique on the market.

Lebas (1995) and Kaplan and Norton (1992) articulate that PMS can be expressed by complementary and contradictory performance indicators at the same time as long as it achieves the desired outcome.

As SP' owners have often contradictory expectations the proposed PMS includes complementary as well as contradictory indicators. It will be up to the SPs to decide which KPIs are the most relevant to them. The proposed methodology offers guidelines on how to develop, implement and use the tool.

The final generic PMS for SP (table 2) indicates five KPIs (from 1 to 5, 1 being the most important

KPIs) selected by the SPs according to their ownership models.

The KPIs are an indication or inspiration for SPs rather than a fixed proposition.

The tool gives SPs flexibility to choose the most adequate KPIs according to their ownership models and unique needs. Moreover, as SPs grow and mature or change their ownership structures they may want to modify their KPIs. The tool allows to do so.

Developing a customised PMS should involve SP's owners and managers to work together in order to define/identify or clarify strategic objectives which will enable them to select KPIs. The idea of bringing the primary stakeholders together with the management of the park is to engage the owners in the SP's life and for them to understand the SP's operational challenges.

In order to carry out a performance measurement exercise, it will be necessary to establish a baseline (one of the columns on the table) to demonstrate the current situation and past performance as well as define targets. Targets should be agreed with current shareholders and the staff members (owners of the indicators).

Time scale, data collection process, data recording, data reporting will also have to be identified. The performance measures will have to be allocated to individuals or departments and may be linked to the park's reward system.

Moreover, benchmark data can be obtained to compare the results.

As SPs vary considerably in terms of size, objectives, contexts, maturity stage, selection of a suitable benchmark is important.

In order to find the most suitable benchmark a SP can use for instance Strategigram or Aspire.

Strategigram is an IASP software development tool that helps managers identify SP's strategic profile. It helps discover the model of each SPs.

Similarly, Aspire is a quality assurance programme developed by UKSPA which assesses SPs purpose, strategy, governance, business case/plan, policies and local context (UKSPA, 2012).

Hannson (2007) declares that SPs need to integrate themselves into organisations that create knowledge and quality assessment tools are needed to enable changes. By using PMSs SPs will be able to provide visibility of their operations, quality of service and progress made to respond to the changing demands of the local knowledge economy. Moreover, it will enable learning and continuous improvement, one of the characteristics of knowledge intensive organisations who make the existing knowledge valuable to their clients and improve their performance (Miles, 2005).

The designed PMS was designed in accordance with suggestions proposed by Bourne et al. (2003), Kaplan and Norton (1992) and Neely et al. (2002) and exhibits the following features:

- It provides a balanced and multi-dimensional overview of the business. The framework assesses multiple aspects of the SPs' performance including financial and non-financial aspects. The designed framework aims at satisfying all primary stakeholders' needs in terms of measurement requirement in a balanced way.

- It is comprehensive. In order to effectively assess performance of a SP the maximum number of data will have to be gathered and compared with the data from other SPs or assessed against set targets and past results (baseline). The data collection must happen at regular intervals. Having a complete analysis of the operations will give a comprehensive picture of the performance and will identify any shortcomings.

- The matrix is designed in a clear way and provides anyone who may be using it with a concise picture of what to measure and how to measure. One of the motives to design a

standardised performance measurement tool was to obtain a degree of homogeneity in relation to data collection and benchmarking within the SP community. As majority of IASP members do not use English as their main language, the student used clear words and internationally known notions for smooth performance indicators' implementation and good communication between the SPs. Moreover, the researcher offers detailed descriptions and definitions of performance indicators and guidelines for implementation. This aspect has been neglected within other frameworks (Bourne et al. 2003).

- The proposed PMS has been designed to integrate within the SPs processes at vertical (hierarchy) and horizontal (departments) levels to encourage consistency of objectives and actions.

- It also provides information for monitoring past performance as well as planning future performance.

The following indicators were added to the PMS after the survey research and based on the answers to the open-ended questions:

- Level of customer satisfaction (at both service and property levels)
- Number of staff with a post graduate degree (in order to measure quality of the knowledge base of the park staff)
- Park's involvement in the community support (number of charities supported, school projects undertaken, etc.)

As they were not assessed by the questionnaire respondents (not included on the questionnaire), no KPIs have been selected for them. They are highlighted on the generic PMS.

CATEGORIES OF PERFORMANCE / PERFORMANCE PERSPECTIVES	KEY PERFORMANCE INDICATORS FOR DIFFERENT OWNERSHIP MODELS OF SPS							PROPOSED PERFORMANCE INDICATORS	Baseline	Benchmark	Target	Actual
	UNIVERSITY	PUBLIC	PRIVATE	UNI-PUBLIC	TRIPLE HELIX	UNI-PRIVATE	PUBLIC-PRIVATE					
Commercial performance	5	2	1	1	3	1	2	Profitability				
	3	1	3	3	2	2	1	Percentage of occupied space				
	4	4	4			3		Turnover				
				5	5	3		Sales				
							3	Debt management				
			2		5		4	Actual financial performance versus forecasted budget				
	1	3		2	4	3	5	External funding raised by the park				
	2	5	5	4	1	3		Investment returns				
Tenant participation	4	5	3	4	3	2	3	Participation in networking events				
		5		5				Inter-company trading				
	3	2	3	3	2	4		Inter-company trading as a result of SP interventions				
	2		4		4	3	2	Links to universities or other knowledge-based organisations				
	1	3	1	1	1	1	1	Links to universities or other knowledge-based organisations as a result of SP interventions				
		4	4					Additional business / funding raised by companies				
	5	1	2	2	3	5	2	Additional business / funding raised by companies as a result of SP interventions				
							2	Percentage of enquiries as a result of networking / innovation activities				
Companies' growth and innovation profile	3	2	1	2	1	3	2	Percentage of companies growing (turnover)				
		1	2	3	3		1	Percentage of companies growing (staff)				
	2			3	2	1	4	Percentage of spin-out/start-up companies				
			3			5		Percentage of companies which took more office/opened new branches				
	1	4	4	1	5	4	5	Percentage of companies investing in R&D				
	4	5			5	5		Percentage of companies outsourcing R&D /				

									involved in open innovation					
									Percentage of employees having a post graduate degree					
		3	4	4	4		3		Number of products/services developed by tenant companies					
						2	5		Number of patents issued/exploited by tenants					
					5				Number of products licensed in and out					
	3								Number of publications					
International profile	3	1	1	2	3	2	2		Number of inward investment companies coming to the park					
	1	2	2	1	2	2	1		Number of companies carrying out international activities (buying or selling abroad)					
	2	3	3	4	1	1	3		Number of companies whose technologies have been applied in other countries and generate considerable impact outside the country of origin					
	5	4	4	3	4	3	3		Number of inward visits to the park					
						4			Number of countries involved in inward visits					
				5			4		Number of good quality invitations to speak or participate in seminar					
	4	4	5		5	4			Number of requests to take part in studies and benchmarking exercises					
Brand and reputation	3	2		3	1	4	2		Number of awards won by the park					
	1	1	1	1	1	2	3		Number of positive press releases about the SP or successful company based on the park					
	5		4						Number of neutral press releases					
				4					Number of negative press releases					
	5	4	3	2			5		Number of referrals from other organisations					
	2	3	2	2	3	1	1		Number of companies in the SP network					
	4	5	5		2	3	4		Number of external companies attending events organised by the park					
					4	5			Percentage of enquiries from appropriate organisations					
Internal business processes	3	2	1	2	1	2	1		Level of employee satisfaction					
									Level of customer satisfaction *					
									Number of staff with a post graduate degree *					
					5				Number of employees being sick for more than average					
	5						4		Percentage of unforced billing errors					
	2	1	1	1	2	1	2		Time taken to fix tenants' complaints					

	5	4	2	3	4	3	5	Number of security indcidents				
	1	4	3	4	3	4	3	Number of ICT outages lasting > 1 hour				
	4	3	4	4		5		Reduction of carbon footprint				
								Park's involvement in the community support* (number of charities supported, school projects undertaken, etc.)				
Park's impact on regional economy	1	1	1	1	1	1	1	Number of jobs created by companies				
	3	2	3	2	3	3	2	Survival rates of tenants that have passed through the SP				
			3					Length of life of the companies based on the park				
			4	5		5		Average salary paid by park's companies to their employees				
		3		4	4	4	3	Companies' turnover by sector				
		4	4	5				Gross value added per employee				
	4							Gross value added per sector				
	3				4		4	Value of companies' purchase				
	2	2	2	3	2	2	2	Total investment attracted by the park and its companies				

* Indicators added after the survey research

Table 2. Final generic PMS for SPs

Conclusions

By proposing a PMS with measures to be used by SPs to assess different dimensions of the business the researcher tried to overcome one of the biggest limitations existing within the literature on performance measurement i.e. the lack of practical information on measures to be used by companies and lack of information how to implement them (Garengo et al., 2005; Brem et al., 2008; Striteska and Spickova, 2012).

It can be concluded that a generic PMS can be adapted to suit the requirements of most SPs as it includes a comprehensive and flexible set of indicators that were proposed as an outcome of the participatory work with the primary stakeholders and the customers. However, in order to customise the generic PMS engagement of the primary stakeholders is required to adequately select the indicators.

Involvement of the shareholders as well as commitments of the management and the staff will influence performance measurement of the park and its ability to demonstrate the results of its actions. Carter (1989) says that the attitude and roles of major parties involved is a critical determinant of the success for SPs.

Performance management involves continuous collection of data. By introducing homogeneity within the SP sector towards performance measurement, the data collection process and analysis will become more straightforward for the SP sector. Moreover, SPs' performance information will be then a valuable input into evaluation studies which focus mainly on demonstrating impact a SP has generated on the regional economy over a couple of years or decades.

SPs are complex and unique constructs with many different elements, including characteristics of knowledge intensive organisations. Although, the researcher tried to identify most of the performance measures, as SPs mature and evolve, it may be necessary to add new dimensions of performance.

Moreover, the research also provided strong evidence that SPs show characteristics of knowledge intensive organisations and therefore challenged Hansson's perspective who claimed in 2007 that SPs live in the shadow of industrial economy, are not real players within the knowledge economy and fail to show attributes of knowledge organisations. Although it is an interesting subject, it is not within the scope of this paper and will be discussed as a separate topic in the future.

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APPENDICES

Appendix 1. SP performance measurement literature

Key literature	Country	Year of analysis	Methodology	Key outcomes
Science Parks and The Growth of High Technology Firms Monck,Porter,Quintas, Storey and Wynarczyk (1988)	UK	1986	Survey of on-park firms (183) and off-park firms (101) - match sample	NTBFs located on the science park have similar closure rate to non-science park firms.
High-tech Fantasies – Science Parks in Society, Science and Space Massey, Quintas and Wield (1992)	UK	1986	Empirical evaluation (re-interpretation of the study by Monck et al. 1986)	Jobs on science parks are not created but simply relocated. Science parks are involved in small innovations rather than in major innovative break-throughs (not innovators per se)
Technology in the Garden Goldstein and Luger (1991)	USA	1989	Case study and survey of 72 US parks	Science park have a positive impact on regional economic development, they help to generate jobs (especially within minorities) and strengthen economic diversity.
Science parks and the growth of new technology-based firms – academic-industry	Sweden	1999	Match sample	NTBFs have more to have links with

links, innovation and markets Lindelöf and Löfsten (2002)				HEIs than off-park firms
How effective are technology incubators? Evidence from Italy Colombo, Delmastro (2002)	Italy	2000	Match sample On-incubator companies (45) versus off-incubator companies	NTBFs show higher growth than off-NTBFs, incubators attract highly skilled entrepreneurs and have a positive impact on links with HEIs
Assessing the Impact of Science Parks on the Research Productivity of Firms: Exploratory Evidence from the United Kingdom Siegel, Westhead, Wright (2003)	UK	1992	Match sample	Firms located on university research parks are more efficient than companies located off-park in terms of creating new products and/or services and patents
UKSPA/Angle Technology (2003)	UK	2003	Surveys of technology-based firms located on-park (617) and off-park (259) (match sample)	On-park firms have higher growth rates than similar off-park firms. On-park companies employ 10% more full time staff and have higher turnover than off-park companies.
Science Park Location and New Technology-Based Firms in Sweden: Implications for Strategy and Performance	Sweden	1999	Match sample	Differences between on-park and off-park are insignificant in terms of patents, R&D output, new products and service. However, the on-park firms have stronger innovation ability,

Lindelöf and Löfsten (2003)				employment growth, sales and profitability than off-park firms.
US Science Parks: The diffusion of an Innovation and Its Effects on the Academic Mission of Universities Link and Scott (2003)	US	2001	Survey of university provosts	Science parks have positive impact on universities' growth and profile. They enable universities to increase number of publications, patents and facilitate transfer of technologies and easily places graduates.
Proximity as a Resource Base for Competitive Advantage: University-Industry Links for Technology Transfer Lindelöf and Löfsten (2004)	Sweden	1999	Match sample	There is small discrepancy between on-park firms and off-park firms in terms of R&D output. However, on-park firms which have strong relations with the university have higher growth level than similar companies located off-park.
'Science Parks and the Development of NTBFs: Location, Survival and Growth' Ferguson and Olofsson (2004)	Sweden	1995 and 2002	Match sample	There is insignificant difference in sales and employment growth between on-park and off-park firms. However, the on-park firms demonstrate a higher survival rate than the off-park firms.
R&D networks and product innovation patters – academic and non-academic new technology-based firms on science parks Lindelöf and Löfsten (2005)	Sweden	1999	Match sample	No significant difference between the profitability of the NTBFs located in and out science parks

Science Parks in Japan and their value-added contributions to new technology-based firms Fukagawa (2006)	Japan	2001-2003	Match sample	On-park NTBFs exhibit a higher propensity to engage in joint research with research institutes. no significant difference was found between science parks and other types of property-based initiatives with regard to the degree of encouragement provided to tenants to establish localized HEI linkage
The role of science parks and business incubators in converging countries: Evidence from Portugal Ratinho, T., Henriques, E. (2010)	Portugal	2005-2006	Survey and case study of 15 science parks and business incubators	The impact of Portugese science parks on the economic growth is modest. Links with universities and suitable management is critical for the success of science parks and business incubators
A Theoretical and Empirical Analysis of the Decision to Locate on a University Research Park Leyden, Link and Siegel (2007)	US	2006	Match sample	

) The role of the science park in innovationperformance of start-up firms: an empirical analysis of Tsinghua Science Park in Beijing Kazuyuki Motohashi (2013)	China	2008	Surveys of technology-based firms located on-park (68) and off-park (match sample)	On park firms show better innovation performance, while formal research and development collaboration with Tsinghua University plays only a marginal role. However, they benefit from informal connections with faculty members and access to students. Human resource management services by the Science Park management company are highly appreciated by tenant businesses. Finally, networking activities among tenants are found to be weak.
Science Parks' tenants versus out-of-Park firms: who innovates more? A duration model Squicciarini (2008)	Finland	1970-2002	Match sample Survey of a sample of 252 on-park firms versus and off-park firms, before versus after hazard rate of patenting activity	

Appendix 2. Initial PMS for SPs

CATEGORIES OF PERFORMANCE / PERFORMANCE PERSPECTIVES	PROPOSED PERFORMANCE INDICATORS
Commercial performance	Profitability
	Percentage of occupied space
	Turnover
	Sales
	Debt management
	Actual financial performance versus forecasted budget
	External funding raised by the park
	Investment returns
Tenant participation	Participation in networking events
	Inter-company trading
	Inter-company trading as a result of SP interventions
	Links to universities or other knowledge-based organisations
	Links to universities or other knowledge-based organisations as a result of SP interventions
	Additional business / funding raised by companies
	Additional business / funding raised by companies as a result of SP interventions
	Percentage of enquiries as a result of networking / innovation activities
Companies' growth and innovation profile	Percentage of companies growing (turnover)
	Percentage of companies growing (staff)

	Percentage of spin-out/start-up companies
	Percentage of companies which took more office/opened new branches
	Percentage of companies investing in R&D
	Percentage of companies outsourcing R&D / involved in open innovation
	Percentage of employees having a post graduate degree
	Number of products/services developed by tenant companies
	Number of patents issued/exploited by tenants
	Number of products licensed in and out
	Number of publications
International profile	Number of inward investment companies coming to the park
	Number of companies carrying out international activities (buying or selling abroad)
	Number of companies whose technologies have been applied in other countries and generate considerable impact outside the country of origin
	Number of inward visits to the park
	Number of countries involved in inward visits
	Number of good quality invitations to speak or participate in seminar
	Number of requests to take part in studies and benchmarking exercises
Brand and reputation	Number of awards won by the park
	Number of positive press releases about the SP or successful company based on the park

	Number of neutral press releases
	Number of negative press releases
	Number of referrals from other organisations
	Number of companies in the SP network
	Number of external companies attending events organised by the park
	Percentage of enquiries from appropriate organisations
Internal business processes	Level of employee satisfaction
	Number of employees being sick for more than average
	Percentage of unforced billing errors
	Time taken to fix tenants' complaints
	Number of security indcidents
	Number of ICT outages lasting > 1 hour
	Reduction of carbon footprint
Park's impact on regional economy	Number of jobs created by companies
	Survival rates of tenants that have passed through the SP
	Length of life of the companies based on the park
	Average salary paid by park's companies to their employees
	Companies' turnover by sector
	Gross value added per employee
	Gross value added per sector
	Value of companies' purchase
	Total investment attracted by the park and its companies