An Approach for Sigrid[1] Validation Methodology as an Evaluation Method for Science Parks Management: The Case of the Madrid Science Park and Park of the University Carlos III of Madrid

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Abstract

In the context of entrepreneurial universities, different initiatives have been launched to promote and stimulate activity. One of them is the case of Science Parks, a key instrument to promote both the interaction of universities with the business sector and the regional and innovative development where they establish themselves. In this way, Science Parks (STPs), like as any other action, needs to be evaluated. The absence of methodologies, indicators and, definitively, homogeneous practices of the global STPs in the assessment of their performance has motivated the present research. This work is a study conducted to validate the SIGRID methodology as a management tool based on stable models -as that of the EFQM, the balance scorecard of Norton and Kaplan and other models of business management- to know the efficiency of Science Parks. To do this, across qualitative analyses of case, the methodology is applied in two different Science Parks. The results conclude that i) only half of the indicators of the current model are coincidental in importance and comparability, ii) the model in its initial proposal is not useful to compare between parks, however partially is applicable for the solidity on which it is based and iii) the model provides useful information for the internal management and external communication of each park. Therefore, the next research phase suggests a measure to deepen in the utility of the subsets indicators – in both ways- relevant or not. After that, we suggested the post exploration and categorization of the relevant indicators of different kinds of parks.

Introduction and Justification

In the current knowledge economy (OECD, 1998), the development of a country or region necessarily implies transformation into the new knowledge innovation through the transformation of goods and services in the industry so as to generate wealth and drive improvements of citizens' quality of life.

One should note the complexity and difficulty in evaluating the success of the STPs. This complexity emerges from i) the intangible nature of knowledge, ii) no obligatory nature of disseminating information to the society based on the intangible capital of an entity and iii) the absence of methodologies and indicators and, definitively, homogeneous practices of the global STPs in the assessment of their performance. Without these reports, any approximation to the evaluation of the STPs is questionable and seems limited, and incomplete. (Luger and Goldstein, 1991; Saxenian, 1992; Appold, 2004; Monck and Peters, 2009, Dabrowska, 2010; Andersen, 2010; Vásquez, 2012; Sanz, 2012 and Herrero-Villa, 2014).

The general objective of this work is to validate the SIGRID methodology as a management tool based on stable models -as that of the EFQM, the balance scorecard of control Norton and Kaplan and other models of business management- to know the efficiency of the Science Parks.

[1] System management and performance measurement in R&D centres. This methodology stems from a cooperation of several years between the Ministry of Education of Madrid, Robotiker-Tecnalia, LABEIN, ESI European Software Institute, AZTI, the Polytechnic University of Madrid and the Complutense University of Madrid

To do this, a case analysis is presented taking two scientific parks as a sample: the Scientific Park of Madrid and the Science Park of the University Carlos III. This Study case will allow us to validate the methodology according to the following specific aspects:

- Measure the intangible potential of the parks
- Continue a few principles of utilization that relate to current trends of management and attempt to ensure the permanency and sustainability of the organizations
- Provide a communication tool of their contribution of value to the society

The structure of this publication appears in the following epigraphs: evidence, theoretical framework, the methodology, results and conclusions.

Empirical Evidence

Currently, the measurement of the performance of STPs follows two methods of analysis. The first examine the added value to the territory. This method line is developed through the analysis of the STPs' contribution to the economy on a regional/national scale based on the economic performance of the companies within the same STP. The value induced in terms of social development is also considered. (Luger and Goldstein, 1991; Monck and Peters, 2001; Infyde 2011). The second compares the performance of the companies within and without the STPs on certain indicators chosen in every case and, generally, on samples of diverse databases.
This second method is wider and, according to the type of variable considered, can be summarized as follows:

i. The financial variables: the growth of employment in correlation with sales (Colombo and Delmastro, 2002; UKSPA-Angle Technology, 2003; Ferguson and Olofsson, 2004; Löfsten and Lindelöf, 2001,2002, 2003; Monck et al, 1988; Universidad de Arizona, 2009; Yang et al, 2009; FECYT, 2011; Herrero-Villa, 2014).
ii. The relative variables at the innovation level , which can be classified in analysis of input and output terms of research and development, the first with two differentiated aspects: a) the relations with the university and b) the intensity and capacity of the company for research and development, (Westhead, 1997; Monck et al, 1999; Löfsten and Lindelöf, 2003; UKSPA, 2003; Lindelöf and Löfsten, 2004; Felsenstein, 2004; Fukugawa, 2006; Liefner and Hennemann, 2006; Malairaja and Zawdaie, 2008; Tödtling et al, 2008; Villanueva et al, 2010, Ortiz de Urbina-Criado and Montoro-Sánchez, 2011, FECYT, 2011; van Osstrom et al, 2012, Herrero-Villa, 2014). The second is grouped into a) the studies tied to the implications of intellectual property (in the Anglo-Saxon sense) of the patents and copyrights, and b) the product innovation. (Westhead, 1997; Monck et al, 1999; Colombo and Delmastro, 2002; Lindelöf and Löfsten, 2003; Löfsten and Lindelöf, 2003; Siegel et al, 2003; UKSPA, 2003; Felsenstein, 2004; Liefner and Hennemann, 2006; Squicciarini, 2008; Ortiz de Urbina-Criado and Montoro-Sánchez, 2011; FECYT, 2011; Herrero-Villa, 2014).

The results showed for all the studies cited are different, particularly those concerning the relative variables at the innovation level.

In other words, from the previous statements, it is clear that a valuation with financial indicators on the microeconomic dimension of innovation exists. Nevertheless, in this context where the knowledge is intangible there is a need for a new methodology to identify the performance of these entities and also allows to:

- Measure the intangible potential of the parks
- Continue principles of utilization that relate to current trends of management and tries to ensure the permanency and sustainability of the organizations
- Provide a tool to communication their contribution of value to the society

The management of these intangibles requires the recognition of intellectual capital (Lev et al, 2005a, 2005b; Sanchez, 2008; Accenture, 2012). This requires, according to Project Méritum (2002) describe as the generation of intangible of future economic benefits for the company. It can be summarized as: human capital (integrated by the skill set of the employee), structural capital (formed by the knowledge that remains in the company) and the relational capital (composed by set of resources tied to the external relations of the company).

Human capital is the supplies skills and knowledge to be able to adjust to and anticipate the market.

Nonaka et al (1995) describes how with human capital it is possible to increase organizational knowledge on by considerating the role of tacit knowledge within the company in innovation (based on experience) and interactions with explicit knowledge (learned in formal institutions) where:

- The quality of the interactions is vital for the creation of new knowledge in the organization. The management facilitate an effective exchange between individual knowledge and organizational knowledge, which implies creating a set of conditions orientated to its creation and conversion or transfer (Hidalgo, 2002).
- The creation of organizational knowledge (and its learning capacity and innovation) depends on the mobilization and conversion of the individual tacit knowledge in collectively and explicitly, define what knowledge must be developed and implemented inside the organization.

The development of the complete potential of human capital finds in the company facilitators and barriers to the innovation that they overlap with culture organization (Sáez Vacas et al, 2003; Trillo Holgado and Sánchez Cañizares, 2006; Morcillo, 2007) which compete in a enviroment of uncertainty, needs a flexible model of organization and initiated with the intention of anticipating to the market and / or to have the maximum possible speed of adjustment.

In addition, innovation is collaborative, produced through the efforts developed within and without of the organization. In this concern, STPs are spaces in which the circumstances, infrastructure and knowledge come together for the cooperation and exchange of scientific and technological knowledge orientated to the company.

However, the links between these dimensions of the intangibles management and the innovation is not sufficiently documented yet (Sanchez, 2008). nonetheless, there is evidence of the direct benefit that intangibles management has on the productivity , especially those which his presence demonstrates a high degree of management of intellectual capital (Accenture, 2012; Gonzalez-Loureiro and Figueroa-Dorrego, 2012).

Methodology

The bibliographical revision has brought us to the conclusion that it is difficult to directly apply the existing models of management to the process of technology transfer, and the institutions must shift from management based on the material assets to strategies based on management of knowledge.
By utilizing the SIGRID model in the current research, we provide a clear picture of relationships between different components of the organization and the relevant processes for the technology transfer to different levels in its structure in order to obtain an open system, flexible and dynamic, capable of adapting to the different types of KTOs and other organisms of transfer.

The above mentioned model is based on stable models as that of the EFQM and the balance scorecard of Norton and Kaplan and other models of business management. The models mentioned previously outline the principal factors of the quality of management offered by the organizations.

The EFQM model provides five agents to measure the evidence (leadership, policy and strategy, management of the personnel, alliances and resources and processes) and four results to measure the consequences of the management decisions made (results for clients, people, in society and key results). On the other hand, the balance scorecard of Norton and Kaplan evaluates the initiatives to improve the quality, capacity of response and efficiency of the internal processes from the point of view of the strategy implantation and management (Pastor, J. 2007).

SIGRID Model

Origins and Basic Approach

The model emerges from a research group founded by public and private entities, which has developed a research project to construct a measurement system management and performance in R & D centers (SIGRID model). The primary motivation behind the model is the current absence of methodologies and indicators in the assessment of the performance of the centers for technology transfer.

The central idea of the model comes from perceived lack of efficiency of technology transfers. This desire for efficiency and control steered the work toward a model of management to support the responsible for technology transfer to improve and re-design their processes in such a way that, in all phases, value is added (Molero 2008).

The structure and logic of the SIGRID model attempts to response to a series of necessary components that habitually appear in the use of a model of management:

- Clear and concise methodology, which facilitates the understanding, communication and application of the Model;
- Analytical and dynamic character that allows the application of the principles of continuous improvement in management;
- Flexibility for the adjustment to the idiosyncrasies of every organization and facility in the alignment with its strategy;
- Measurement of relevant aspects to be able to estimate the attainment of concrete results and the efficiency of the system of management

Therefore, a good model of management must present the possibility of facilitating an integrated approach, which, on one hand, orientates the management of assets and the beginning of improvements, and in the other hand, allows the measurement of its application and provides universal results. Another relevant aspect are the guidelines for its systematic application. SIGRID model is supported by both the annual measurement of a scoreboard of relevant indicators and the possibility of penetrating concrete aspects of the process of technological transfer.

SIGRID (figure 1), facilitates the "implantation of internal systems of quality as well as the establishment of activity indicators and measures a management performance, essential elements for its constant improvement and auto-evaluation, a in turn, a major efficiency of the technological transfer and of the results of research". SIGRID has conceptualized a model of organization which contemplates the following dimensions detailed in 209 indicators.

Figure 1: Dimensions of SIGRID Model

<table>
<tr><th colspan="2">MECHANISMS OF TRANSFERENCE</th></tr>
<tr><td colspan="2">• Projects of R & D
• NTBS (New Technology Based Firms)
• Licenses of patents and products</td></tr>
<tr><th>FACILITATORS AGENTS</th><th>RESULTS</th></tr>
<tr><td>• The human capital (persons, capacity, formation)
• Organization / infrastructures
• The relational capital (alliances and relations)
• Politcy and strategy
• Culture</td><td>• Companies
• Scientific community
• Society</td></tr>
</table>

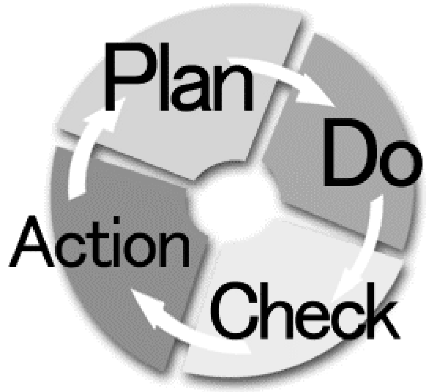
Source: Own elaboration based on SIGRID document, 2008.

1. Facilitators agents: Dimensions that define the capacity of the organization to propose and develop the technology, initiating the chain of value for the technological transfer of the KTO.
2. Mechanisms of technology transfer: technological services across which the technological transfer is done.
3. Results: It is an effect and consequence of the implications of the agents facilitators in the mechanisms.

One of the key points is the identification of the indicators related to the generation of competence in the organizations and the transfer of technology.

The SIGRID model contemplates the utilization of the cycle PDCA (figures 2). It is a basic methodological process of continued improvement (Walter Shewart and DEMING). This cycle should be implemented in order to progress in management improving and achieve the objectives.

Figure 2: Cycle PDCA



Source: SIGRID document, 2008.

Finally, as it was stated previously, the model is supported by the annual measurement of the balance scorecard of relevant indicators and the possibility of penetrating concrete aspects of the process of technological transfer (figure 3).

Figure 3: Temporary Description of Management Dynamics for Centers of Technology Transference

PLANIFICATION	MONITORING	EVALUATION
Definition of anual objectives: Filling the target values of the indicators.	Indicators are filled in periodicity. Monthly review of the scorecard. See the evolution of indicators in the year. Chance of benchmarking (by size, type, geographic area, etc.)	Annual report. Reflexion of the following years.

Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9	Month 10	Month 11	Month 12

Source: SIGRID document, 2008.

Having described the methodology, an exploratory data analysis emerges that allows an initial characterization of the parks and businesses located within the same approximation, and the impact that they have on their environment is analyzed using the established indicators.

Interviews semistructured to personnel of the parks gather opinions that allow us to orientate better the interpretation of the results to improve conclusions.

Results

To carry out the validation of the methodology two institutions were selected: The Scientific Park of Madrid (SPM) and the Park of the University Carlos III of Madrid (PC-UC3M). The rate of response obtained was 100%. Both parks have been in operation for over 10 years, nonetheless they present some differences both in their nature and the governance:

The PCM is a non-profit foundation created by the Complutense University of Madrid and the Autonomous University of Madrid. It is supported by: Town hall of Madrid, Town hall of Tres Cantos, Higher Council for Scientific Research (CSIC), Institute of health Carlos III, Santander Bank, the Chamber of Trade and Industry of Madrid and the Center of Energetic, Environmental and Technological Research (CIEMAT). Its main activity is to serve as an incubator of companies, specialized in biotechnological companies.

The PC-UC3M is a unit of the University Carlos III of Madrid managed by the Vice- rector's office of Research and Transfer. Its purpose, besides the incubation of companies of technological base (necessary condition to take part in the program), includes the protection of potentially marketable research of the above mentioned university, and the creation of collaborative centers (university - company) for R&D and innovation.

Table 1 is the result of the application of the survey to both institutions. This table shows the shared characteristics for the indicators of the SIGRID methodology grouped by their dimension

Table 1: Correlation indicators

		Correlation			
				Total	
Indicators	**Dimension**	**Null**	**Partial**	**Positive correlation**	**Negative correlation**
Facilitators	Human capital	10	6	11	0
	Relational capital	6	1	22	0
	Culture	3		2	0
	Leadership	2	1	4	0
	Organization	9	4	16	3
	Policy and Strategic	2		2	1
Mechanisms	NEBT's	3		7	0
	Patent	13			
	Projects	9			
Results	Scientific Comunnity	2		11	2
	Enterprises	20	1	12	4
	Society	10	1	5	4
Total		89	14	92	14

Source: Own elaboration based on the output results, 2014.

The null correlations (zero values) come from those indicators that cannot be compared because the activity is not relevant to the sample. This is the case for patent management. While the PC-UC3M has their own staff managing patents, the PCM does not manage the activity. Instead, the park only provides contacts to those companies that negotiate patents by them. Another element that has been included in this group of indicators is entrepreneurship: The PCM does not have an entrepreneurship service. The park only accepts existing companies and serves as an incubator for technologically based companies. It also provides them with both high quality spaces and complementary access to R&D. The PC-UC3M by contrast, offers this benefit within its catalogue of services through a business incubator that favors the creation and consolidation of new companies.
Both indicators mentioned previously are the most relevant inside this category. It is interesting to note that these indicators represent 42 % of the total, which supposes an adjustment of the methodology.

The partial correlation are those where the indicators need a deeper explanation: In this group we gather those indicators where one of the institutions did not provide information because they did not have the information required: people with creative skills, R&D programs evaluators, knowledge of the managerial reality of the supportive personnel, people with a promoter profile, sufficient resources, decision on PI's assets, improvement of leadership in base 360º and returns on R&D.

Shared characteristics come from those indicators in which both parks qualify (positive correlation) or do not qualify (negative correlation). Within the positive coincidences we can mention indicators like: doctorate degrees in staff, total within staff, number of researchers, areas of research, products of collaborations with universities, cluster/community of practices to which it belongs, number of projects in which it takes part across a community of practices, strategic agreements of collaboration, rotation, retention, capture; only to name a few. It is important to note two observations inside this group:

1) There have been indicators that are correlated coincidental, however they need a certain shade for his measurement, for example: the degree of satisfaction with teamwork, degree of satisfaction with respect to the persons, satisfaction of the staff, degree of satisfaction with the immediate superior, where it has been suggested to do a scale of measurement for the homogenization of the response and

2) Some indicators found that, when the survey was done, the information was not available. Such is the case of some indicators like: time destined for training, number of technical courses, number of appearances in media, number of articles presented for his publication, number of papers, number of assisted congresses, investigative capacity, technical efficiency of projects, economic efficiency of projects, profitability of projects, productivity and prizes and recognitions.

Finally the negative correlations, that is, those activities in which in none of the two parks qualify, we can mention the following: system of technological vigilance, number of citation of scientific literature, % donated patents, donations received of the scientific community, donations perceived of the private sector, number of inventions in which the subject made the decision not to ask for the protection of PI. Table 2 shows those indicators that can be compared. Those indicators are applicable in both Scientific Parks and represent the 44% of the total.

Table 2: Comparability of Indicators

Facilitators
Human Capital
Learning / Profile diversity
People with manager profile
Research excellence
Doctorate degrees in staff
Experience in research
people with research profile
Fidelity/satisfaction
% of promotions
Antique average
Degree of satisfaction respect to the persons
Degree of satisfaction with the teamwork
Perspective of future
Rotation
Satisfaction of staff
Relational Capital
Commercial activity
Number of companies clients
Number companies visited (new clients and ancient)
Number offers realized (diverse ratios)
Number of persons dedicated to the commercial activity
Alliances, platforms and nets
Alliances with universities
Cluster/ Community of practices to that it belongs
strategic agreements of collaboration
Number of projects in which ittakes part across community of practices
Capital/financiation
Financiation
Relation with financial institutions
Different marketing techniques
Number of appearances inmedia
Number of articles presented for his publication
Number of assisted congresses
Number of technical courses
Number of presentations
Number of leads generated by congress

Customer loyalty
Captation
Retention
Rotation
Mercado
Relationship with customers and suppliers
Other entities
Reations with incubators
Suppliers
Level of suppliers (suppliers evaluated satisfactorily)
Culture
Referents
Positive experiences
Values
Degree of implantation of the values of the culture that we want to have
Leadership
Improves perception of leadership
Degree of satisfaction with the immediate chief
Degree of satisfaction of the direction
Satisfaction of the community
Rating items such as innovation, customer focus
Organization
Structure
Accessibility of the scientific technical equipment
Infrastructures of support to the entrepreneurship
Infraestructure and Informations Systems
Corporate tools
Use of information systems for people
Technology offer
Research lines
Specialized products / commercial products
Time to launch new products
Process Improvement and Organizational Learning
Age of certifications
Learning through lessons learned and best practices
Internal audits
EFQM self-assessments
Number of certifications according to standard rules
Number of forums to share / cluster in which it participates
Number of ongoing projects Benchmarking
Number of projects in collaboration with other scientific institutions
Employee Suggestion
Policy ans Strategic
Compliance objectives
Defined strategy
Degree of fulfillment of the objectives
Mechanisms
NEBT's
Prototype enterprise
Companies generated
NEOTEC proyect
Incubation
5-year survival
3-year survival
Business plan
Plans approved
Externally funded plans
Plans generated

Results
Scientific Community
Diffusion impact
% Costs borne by the sector inquiry
% Ongoing projects with private companies
% Ongoing projects with other institutions
Satisfaction surveys of the scientific community
Number technical articles in specialized magazines
Number citing articles
Number of proceesing at conferences
Number tech news
Number presentations at conferences / seminars / workshops minarios/jornadas
Number publications in academic journals
Awards received in the scientific community
Companies
Financial/economic results
% Projects with foreign entities
% Sponsored research projects
Transfer proximity market
Hiring R&D
Hiring for R&D programs
Hiring projects with companies
Total hiring projects
Number of R&D projects
Productivity
Added value
Value generated
Anual profitability
Economic return
Society
Media impact
Media impact of companies created
People involved
Awards
Jobs created
Technical jobs generated
Rating technical courses

Source: Own elaboration based on the output results, 2014.

According to the table, 92 indicators are the result of the comparative study between both parks and that turned out to be the coincidence of 209 analyzed indicators, and therefore, are not an object of modification and adjustment since they turn out to be those that they allow up to the moment, to realize a comparative study between different Science Parks.

Conclusions

According to the two analyzed groups, we found that there are disparities with respect to the activities and processes, for which it is necessary to evolve the indicators and adapt them to the needs of the Science Parks. We suggest a typology of every park to which one could apply the indicators

According to those indicators which partially overlap, it will be useful in such a way that the needed information does not generate conflicts and therefore the results are not affected.

The model offers valid information for every park, since it provides information that normally is not show in annual reports, enriching communications with stakeholders.

In summary, the model as studied in its initial proposal is not useful as a comparison between parks, which requires modification and adaptation of indicators. However, the model is partially applicable to evaluate these institutions by soundness in which it is based.

Finally, as for future studies, we suggest the following: to improve the convenience of the indicators that seem less relevant and further exploration to encourage a categorization of the subsets indicators linked to the different natures of parks and within it the indicators to fit and to reevaluate the methodology to check its continued relevance in the comparative analysis of different Science Parks.

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