Innovation infrastructures assessment through knowledge management models

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Abstract. The design and implementation of innovative infrastructures to support business activities have been carried out in our country over the last years. There have been significant investments, which have often been unsuccessful and very expensive, since they have been based on opportunistic criteria far away from objective and professional criteria. However, there have also been successful cases that have endured over time. This paper proposes a model to help managers and authorities to make future decisions concerning the design and implementation of such infrastructures. This model should be based on a future-oriented focus and on knowledge and experience of the different stakeholders from different fields of knowledge who have an important participation in the design and development process. This model should allow assessing, a priori or at any stage thereof, the probabilities of success of such initiatives in a quantitative way.

Keywords: innovative infrastructures, knowledge management, technological parks.

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Resumen. En el diseño e implementación de infraestructuras innovadoras de apoyo al desarrollo empresarial que se han venido desarrollando en nuestro país, se han producido importantes inversiones que en muchos casos han sido fallidas y muy costosas, ya que se han basado, a veces, en criterios oportunistas alejados de criterios objetivos y profesionales. No obstante, sí que se han producido iniciativas de éxito que han perdurado en el tiempo. En este trabajo se propone diseñar un modelo orientado al futuro y basado en el conocimiento y experiencia profesional de los diferentes promotores y gestores profesionales que han participado en el diseño y desarrollo de este tipo de infraestructuras, provenientes de diferentes campos de conocimiento. Este modelo debería permitir evaluar a priori, o en cualquier estadio del mismo, las probabilidades de éxito de tales iniciativas de forma cuantitativa.

Palabras clave: Infraestructuras de innovación, gestión del conocimiento, parques tecnológicos.

1 Introduction

Most authorities and professionals agree that if companies play a key role on Innovation Systems in recent years it is because of their ability to transform R & D activities in economic development and wealth. That is why most governmental innovation policies focus on the participation of companies in the innovation process as a key factor in the competitiveness of different regions and countries. Of the various innovative infrastructures developed to facilitate this type of business activities, one is the Scientific and Technology Parks (STPs). STPs act as engines of innovation, as agents for economic development, and as a crucial link between companies and university researchers. They can be considered to play an important role in innovation processes and in generating the corresponding synergies.

Taking into account the above considerations, what are the key factors in the success of STPs? Is it possible to design and implement a model to help policy-makers and managers in their decision-making process in order to predict the probability of success of these infrastructures in advance and avoid failed investments? Not many references in the literature focus on this specific issue for the Spanish case. Among them, Lopez (2003) analyzes the functional elements and the criteria for sizing, designing and managing STPs, which is eminently based on town planning aspects. Gonzalez (2004) studies business networks of technology-based enterprises, focusing on research cooperation, development and innovation in the field of dissemination and technology transfer in order to obtain the factors or variables that affect the performance of such networks. Ruiz (2002) presents a theoretical model based on the concept of innovation systems. Two types of models have been proposed for regional innovation systems assessment, based on two

types of analysis variables: available resources and obtained results, two factors which are closely linked (Landabaso, 1997; Landabaso et al, 1999; Morgan and Nauwealers, 1999). Following that trail, Heijs, Martinez, Baumert and Buesa (2002), presented a classification and characterization of the different Spanish regions with respect to their innovation systems.

2 Research methodology: proposed model and results

This paper seeks to provide a transversal model, future-oriented, to evaluate STPs and thus help in the decision-making process of public authorities and regional councils. Given that data on the future does not exist, our model is based on experience, knowledge, opinions, intuition and tacit knowledge from experts in the field of STPs belonging to different areas of knowledge (managers and researchers of scientific and technological parks, business people who have worked on or have established their businesses in these parks, as well as university professors and researchers), and who have been working and researching collaboratively in such initiatives. We based our work on the following tools: (1) the European Innovation Scoreboard, in order to determine the key indicators of success; (2) the Likert scale, used for the assessment and quantification of different parameters, aspects and criteria; (3) the EFQM quality model, used to design the structure of our model; and (4) the Delphi model, crucial in the development of this work, for collecting and identifying the tacit knowledge and professional experiences of experts in this field. We collected additional data from the Territorial Statistical Analysis System of Andalusia, and processed it using the statistical software SPSS.

2.1 Proposed model

In order to collect and use the knowledge, experience and intuition of experts on STPs, we directed our efforts towards the Delphi methodology against other possibilities, such as the Balanced Scoreboard, neural networks or fuzzy logic, which usually avoid or bypass the underlying intermediate processes. Table 1 shows the main details of our Delphi process, and Table 2 shows the questionnaire sent to the experts, to assess each criterion and establish the corresponding weight. The weights were set for each aspect of each criterion in a similar way. Finally, our Delphi team, in correspondence with the data gathered and the opinions expressed by the experts, proposed the criteria and aspects shown in Table 3 as the main evaluation parameters of the synthetic index. As a final result, the team proposed the model structure shown in Figure 1, where the synthetic indicator is set according to environmental, technical and strategic criteria, and their weights correspond to the results of the Delphi process.

Table 1. Description of the Delphi experiment.

Panel members	No	1st round responses	% of success in the 1st round	2nd round responses	% of success in the 2nd round
Scientific experts	35	29	83%	20	57%
Entrepreneurs	19	16	84%	9	47%
Administration experts	15	15	100%	10	67%
TOTAL	69	60	87%	39	57%

Table 2. Questionnaire sent to the participating experts.

Questions	Weight of aspects P_{ij} ... P_{ij}... P_{ij} ..... P_{ij}
Interest in R & D in general Need to integrate new agents in the Andalusian Innovation System Adequacy of research with industry needs Current availability of resources from the Public Administration Coordination between the interface, the Andalusian Public Administration and private agents Level of cooperation between business firms to develop projects of I + D I Knowledge by firms in the supply and demand for services Availability of information on business opportunities in international markets Appropriateness of the specialized services (logistics, reengineering, special consulting ...) Availability of financial instruments to promote innovation Offer specialized technological infrastructures (science parks) Knowledge of the industry by tax incentives Existence of measures to support the creation of new technology-based companies Level of information received by consumers on aspects of processes Existence of mechanisms to inform the company on consumer preferences Level of attention from companies to consumers' demands Current presence of automation and robotic technologies in the sector Degree of incorporation of new conservation technologies and packaging Degree of implementation of Information Technology and Communication Importance attached by firms to knowledge management and optimization Ability of firms to manage innovation projects Human capital capacity of firms to innovate Degree of implementation of environmental management (waste and byproducts) It is better to build PCT no focus in specific sectors Andalusian food industry has the capacity to have enough viability Importance of creating a network specialized in specific sector parks STP are considered more appropriate as multi-sector focus Would choose to implement these infrastructures in depressed areas Would choose to implement these infrastructures in dynamic areas where the viability is higher Importance of entrepreneurship in these initiatives Importance of Management Importance of human resources available in the region Importance of dynamic and innovative business network for success Importance of territorial scope (character of the area where it is located) Importance of the technical proposal (plot, cost ...) Importance of the existence of interface agents to influence the success of the CIT and research groups Considered adequate agricultural region as the geographical unit of study Importance of the distance between STP	
% of Weight of aspects	

Table 3. Main criteria and aspects chosen for the calculation of the synthetic index.

CRITERION	ASPECT
ENVIRONMENTAL	SOCIOECONOMIC
	INNOVATION
	ENVIRONMENTAL ASPECT
	I+D+I SUPPLY AND DEMAND
	SUPPORT STRUCTURES
TECHNICAL	LAND TRANSPORT
	SUPPLY
	SERVICES
	LAND AND PROPERTY LAW
	PLOT CHARACTERISTIC
	ECONOMIC
	FINANCIAL
STRATEGIC	SECTOR
	SCIENCE AND TECHNOLOGY
	MODEL

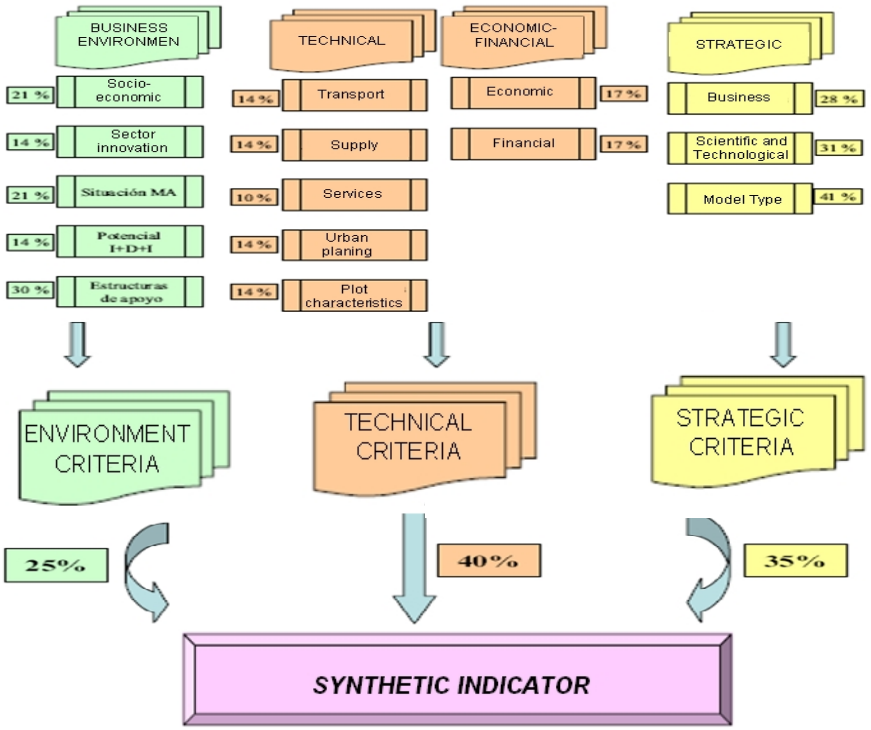

Figure 1. The proposed model

2.2 Application of the proposed model

In order to validate the model, our team applied this model to a set of STPs in different development stages: (Cartuja'93 (Seville), PTA (Málaga), Geolit (Jaén), Velez-Málaga (Málaga), Agroparc (Avignon) and Bioindustry (Piemonte). The results gathered are showed in Table 4. In this table, for each STP, the first column shows the calculated Synthetic Index measured in percentage probability of success, and the remaining columns show the values obtained for the three main criteria conforming the Index and the aspects contemplated in the calculations for each criterion. The main aspect that requires improvement in each STP has been highlighted in red.

Table 4. Results after applying the model to different STPs.

	Synthetic Index %	Environment criterion	Socioeconomic	Innovation	Ecological	I+D+i	Structural	Technical Criterion	Transport	Supplying	Services	Town-planning	Ground	Economic	Financial	Strategic Criterion	Business	Technical	Model
Cartuja 93	**75,0**	**3,90**	**2,86**	**2,75**	5,00	5,00	4,00	**4,02**	4,00	4,00	5,00	3,60	3,33	3,67	4,75	**4,09**	4,25	4,50	3,67
PTA Málaga	**71,0**	**3,65**	**2,71**	3,50	**2,00**	3,50	3,00	**3,44**	3,50	**2,00**	2,33	2,80	4,00	3,67	3,00	**4,48**	4,25	4,00	5,00
Geolit Jaén	**59,7**	**3,69**	3,00	1,75	4,00	5,50	4,50	**3,45**	3,00	2,67	4,00	4,00	3,67	3,67	3,25	**3,13**	2,50	3,00	3,67
Vélez Málaga	**37,0**	**3,27**	4,17	2,75	4,00	2,50	2,75	**2,62**	2,50	**1,17**	**2,00**	2,40	2,33	3,00	4,33	**1,95**	**2,00**	2,50	**1,50**
Agroparc Avignon	**72,6**	**4,16**	4,14	4,71	5,00	4,17	3,33	**3,16**	3,00	4,50	6.67	3,00	3,67	**2,75**	**2,00**	**4,57**	4,50	4,50	4,67
Bioindustry Piemonte	**81,3**	**4,51**	4,14		5,00	4,33	3,33	**4,07**	3,50	4,20	4,33	5,50	4,33	**3,50**	4,25	**4,28**	4,75	4,00	4,17

According to the results, Cartuja'93 is a clear example of success. It was built using the infrastructure from the Expo'92, with a very favorable economic and financial plan. Its economic viability is practically assured. The model shows that only small improvements can be sought in aspects that are difficult to improve because they depend on improvements of private business networks, which can only be achieved in the long term.

In the PTA case, it is a more recent initiative, based on experience and knowledge acquired in Cartuja'93. In both cases, the government support was essential, and their strengths and weaknesses are similar. Some aspects such as socioeconomic and environmental aspects should be improved, but the main difficulty lies in their complexity. However, other aspects like transport have been recently improved (road network and railway), which will hopefully further improve the future performance level. Other clear improvements can also be seen in the recent inter-university agreements (Andalucía Tech) in search of synergies in the field of innovation.

Geolit can not be considered a success case, such as its Synthetic Index shows. It is an even more recent initiative, and with a more specialized bias towards the oleic sector. The regional authorities have tried to promote R&D and value-added

activities oriented to manufacturing processes in the industry, but this is a complex task because the international business dealers are agents with socio-political interests far beyond the regional one. Among the weaknesses we may highlight those related to socio-economic and finance, socio-economic conditions and the weakness relative to the entrepreneurial sector that needs a great improvement. It also has a nearby university, but with a lower potential and research capacity compared to the two previous cases.

Velez-Málaga can be considered a great failure without any doubt, according to its Synthetic Index. Its technical and strategic criteria are too low, possibly due to its proximity to the PTA. We believe that it would be necessary to change the model and reorient the concept in order to exploit the synergies of the proximity of this successful initiative (PTA) and its potential.

The Agroparc D´Avignon is a great success, as shown by its Synthetic index. Its main weaknesses are those concerning economic and financial aspects, but these can be considered secondary problems. It is, as its name implies, a STP focused on the agribusiness sector, and this is a key criterion in the success of the park because it is installed in a region with a clear commitment to the food industry where there is a great tradition in the R&D sector.

The Bioindustry Park is without any doubt the greatest success among the analyzed STPs. The results obtained after applying the model to it present a very high score for the synthetic index and the rest of criteria and aspects. This STP does not really need any specific improvement, since the lowest values, basically related to economic and financial aspects, are significantly high.

4 Conclusions

We have developed a transversal model for the evaluation of the success of STPs, following a Delphi process involving a relevant number of experts in the field. Innovation processes represent a rupture with the past trend, in the way of seeing and / or perform the different processes, activities, etc. Therefore, the use of historical data to validate models concerning future expectations should be avoided when possible, and use instead the previously mentioned "future data" based on the knowledge, experience and intuitions of the different knowledge stakeholders mentioned above, for the validation of such models.

According to our Delphi team, other professionals involved in the project, and other users who have used the model (Technological Corporation of Andalusia, regional and national authorities), the results of the evaluation provided by model, as applied to the different parks analyzed, present a fair and sound assessment. They all agree in considering it a valuable tool to analyze the possible future implementation of a STP or to assess the current status of existing STPs.

Another interesting aspect highlighted by its users is the ease of use and understanding, and the reliability shown by the model. Users believe that having access to information of the intermediate levels of the model allows them to interpret this information in order to suggest improvements or carry out simulation processes which would result from the modification of the input data.

In this model, tacit knowledge and experiences and personal views of expert professionals are embedded in its structure and relative weights, which were obtained according to the different criteria and aspects proposed by the experts. This limits the possible sensitivity analysis, since this structure and weights should not be modified because the essence of the knowledge of the expert group would be lost. A correct application of a sensitivity analysis should be limited to possible changes in some of the input data (e.g. what would be the result if a particular initiative improves technological infrastructure (cable network) or access infrastructure?), without affecting the model structure.

Others analytical and more conventional approaches used in the past, based on economic and financial viability, represent in our opinion a narrower framework. Our model tries to take into account all the relevant factors, incorporating criteria and aspects concerning the environment, technical and strategic issues, that we consider are more complete and demanding from the perspective of the expert group knowledge that permeates the model structure.

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