Classification of Iran Science and Technology Parks Based on the IT Facilities

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Abstract

Today we are witnessing a fast movement from traditional economy towards knowledge-based digital economy (new economy) as a result of breathtaking IT revolution. So Science and Technology Parks, as one of the most important factors in economic growth and regional development, should be frontier in using IT facilities to help their tenants compete with other companies. Furthermore, because of diversity of the science parks in form and function, the academic literature about their classification is sparse and most of the existing taxonomies can not be applied to all countries' science parks. In this paper, we are going to classify science parks based on the IT facilities they provide for their tenants, and then we will apply it on Iranian science parks.

1. Introduction

In today's global economy, it is vital for nations and regions to maintain their competitiveness. A major factor toward this aim is the development of innovative products and services which in turn depends significantly upon the efficiency of the transfer of technology from academic and research institutions into industry. Indeed, many industrialized nations now talk of a 'knowledge-based economy'.

To be successful in these situations, counties should pay more attention to Science and Technology Parks (STPs) which are one of the most impressive factors in transferring the technology from academia into industries.

Because of the high importance of STPs in knowledge-based economy, since the early 1980s, the subject of science parks has generated a vast amount of both direct and indirect literature. Although the literature is very detail and thorough, until recently there has been little attempt to provide a comprehensive taxonomy and evaluation of science parks.

One reason there have been few such comprehensive and critical evaluations and categorizations, is the diversity of STPs in form and function. In employment size, they range from parks with less than one hundred workers to Research Triangle Park's thirty two hundred. In physical dimensions, they range from under three acres to over more than sixty five hundred acres. They differ in organization and ownership: most, but not all, are linked to a university; some are publicly owned, and others operate as private developments. Types of firms found in science parks also vary, ranging from R&D divisions of multinationals, like IBM, to small recently established high-technology enterprises.

Given this diversity, it is so difficult to evaluate and compare these organizations with each other. However a good taxonomy of STPs will be extremely helpful in comparing these elaborate organizations. Unfortunately, despite of having a rich literature of science parks, the academic literature about the classification of them is sparse and most of the existing taxonomies can not be applied to all countries' STPs.

Considering the evolution of science parks in the last decades, it would be clear that there have been dramatic changes in STPs as a result of breathtaking IT revolution in recent years. Today we are facing a fast movement from traditional economy towards "knowledge-based digital economy" (also called "New Economy") and countries are concentrating their efforts on producing high-tech products.

In these situations Science and Technology Parks (STPs), as one of the most important factors in economic growth and regional development, should be frontier in using IT facilities to satisfy their tenants' requirements.
As we go forward, the significance of the IT services are highly increasing and these kinds of services are going to be one of the dominant factors which should be provided by STPs to compete with others.
It is very probable that the taxonomy of STPs based on their IT facilities would be a great help in evaluating these organizations. Our aim in this research includes proposing IT facilities which should be provided by STPs for their tenants in order to compete with other parks in the world. Moreover we will categorize science parks in different levels, based on the IT services they provide for their tenants. After introducing this new classification method, we are going to apply it on Iranian science parks.
We believe this classification has two important advantages compared to preceding taxonomies. First, it is not restricted to any special country and can be applied in all countries and for all types of parks. Second, as we are moving toward the "New Economy" the significance of IT facilities will be highly increasing and this classification would be so helpful in evaluating the science parks. This evaluation would be helpful for both, persons who are in charge with STPs, and persons who looking for an excellent park according to their needs for their firm residence.
We organize the rest of the paper as follows. In section 2, we provide a brief review of different taxonomies of science parks. In section 3, we outline and discuss our methodology in this research. In section 4, we explain our proposed taxonomy. In section 5, we prioritize our identified IT facilities based on their importance. We will apply our model for Iranian parks in section 6. Finally, in section 7, we draw conclusions.

2. Toward the taxonomy of science parks

In this section, we are going to review some of the remarkable works which have been done on classifying the science parks since their emergence.
In 1985, Allesch categorizes the parks into three different groups: "Research Parks", "Innovation centers", and "Science Parks". A "Research Park" is one in which young firms or detached sections of large companies carry on research and development in relatively close cooperation with a nearby university or research establishment and where the development of prototypes, but not mass production is, allowed. An "Innovation Center" provides new high-technology firms with an optimum chance of survival and development by offering an extensive range of services, proximity to university institutions, and the possibility of integration into the local and regional innovation network. "Science parks," on the other hand, are a new way of locating industries: existing firms in innovative technology areas are offered attractive surroundings and proximity to research establishments.
Allesch's definition of "science parks" has two limitations. First, it excludes the possibility of new firms (start-ups and spin-offs) forming within the parks. This omission is significant because one of the primary rationales for the promotion of science parks is the impetus they generate for small-firm formation. Second, it is difficult to sustain his distinction between "science parks" and "research parks" in practice. In reality, many parks include a combination of the three categories set out by Allesch.
In 1989, Joseph used the term "Technology-Oriented Complex" (TOC) for these kinds of institutions. He identifies four types of TOCs, distinguished by the factors that contributed to their initial development (1) TOCs whose growth is principally the product of locally initiated firms and spin-offs, such as Boston's Route 128 and Silicon Valley; (2) research-oriented TOCs usually restricted to a park site, such as Research Triangle Park in North Carolina; (3) TOCs initiated by attracting manufacturing facilities of high-technology companies, as in Phoenix, Arizona; and (4) TOCs that result from large expenditures of government funds, as represented by U.S. space and defense expenditures in Houston, Texas.
Carter (1989) identified three types of strategies for the creation of a science park in the U.K. and categorized the parks into three different groups based on these strategies. The first and least commonly employed approach is a university led and funded strategy, in which a university or a High Education Institution (HEI) establishes a science park and manages it. A second approach is a joint

venture strategy, involving the university or HEI and private investors. Under this approach, the unit is managed by a separate legal entity. The third and most commonly employed method is a co-operative venture strategy, in which the partners work together within a flexible and informal framework. This strategy typically results in only limited involvement of the university or HEI and academics in the day-to-day operations of the unit.

In terms of the relationship between industry and academia, Grayson (1993) identifies various sub-forms. One is "Research Park" as a pure form in which the principal form of activity is academic/industrial liaison in leading edge technologies. Another is "Science Park" as a similar form to the research park in that it is usually located on, or very near to, the university campus but development work is likely to be as important as pure research, and some prototype production facilities may exist. The third is "Technology Park," usually designed to accommodate firms engaged in the commercial application of advanced technologies.

There are also some other taxonomy of science parks based on "Developers", "location" and "developmental stage" which are illustrated in Table 1.

Criteria	Types / Exemplars
Developers	1. Government-led science parks (Taedok, Hsinchu, Sophia-Antipolis) 2. Private-led (spontaneous) science parks (Silicon Valley, Berlin Innovation Center)
Location	1. Independent & remote parks (Sophia-Antipolis) 2. Nearby Metropolitan area parks (Cambridge Science Park) 3. Within Metropolitan area parks (Zhong-Guan-Cun Science City)
Developmental Stage	Science City, industrial park, technopark, information city (Oh and Im, 1999)

Table 1. Some of the typologies of science parks

Capello (1999) categorized science parks based on their development of evolution. This classification is illustrated in Figure 1.

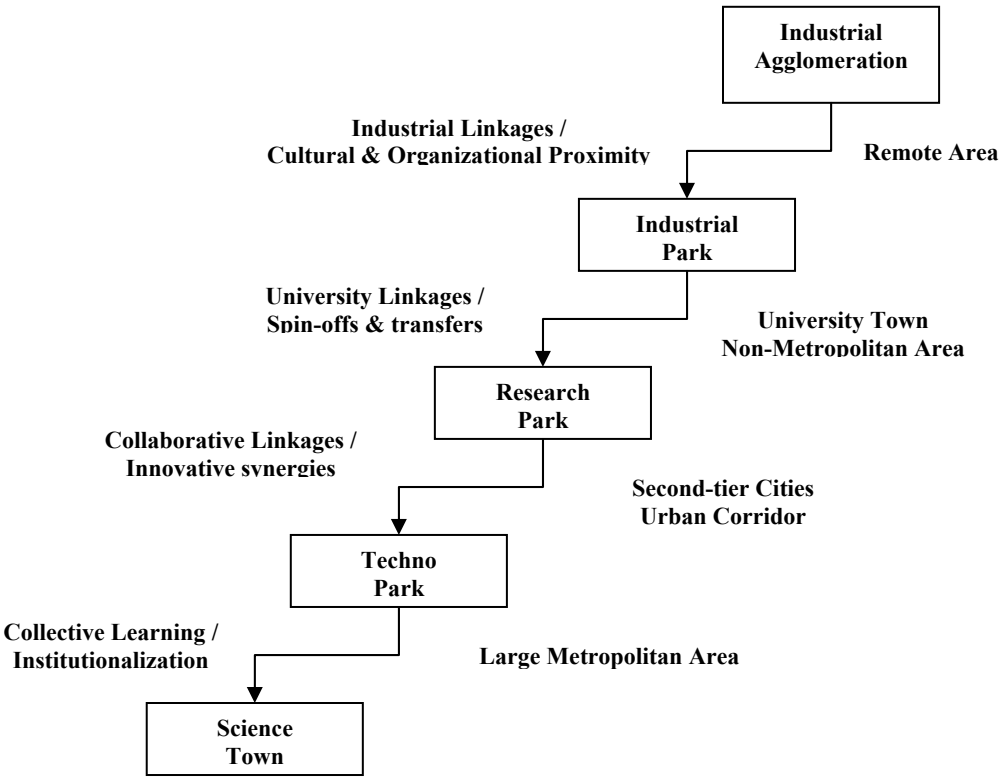

Figure 1. Evolution of Technology Parks

Some, such as Lugar (2001), have posited alternative classification schemes based on third-party information, but to date there has not been a systematic effort to formulate a meaningful taxonomy of science parks. Luger's classification is illustrated in Table 2.

Type	Description
Research Parks	Cater to R&D operations Examples: Research Triangle Park, Stanford Research Park
Science / Technology Parks	Focus on application of science and engineering to the development of new products and processes with commercial potential
High-tech Industrial Parks	Occupants engage primarily in production of relatively high value-added goods
Warehouse / Distribution Parks	Include "Global Transparks" built in Kinston, NC, and Thailand, on sites of decommissioned airfields.
Office / Headquarter Parks	Sales functions, administrative activities, regional presence
Eco-industrial Parks	Input-output linkages among tenants optimized to minimize accumulation/discharge of waste and pollution. Not really a park but a region

Table 2. Luger classification of science parks

Finally, in 2003 Link categorized U.S science parks by dividing them into three different categories:

- Real estate parks with no university affiliation
- University research parks with tenant criteria
- University research parks with no tenant criteria.

Regarding the latter two categories, tenant criteria include, among other things, being R&D and technology based, not conducting heavy manufacturing, and/or being committed to hiring graduate students and interacting with university faculty.
As it is observed, none of the above taxonomies are so comprehensive that can include all kinds of parks in all over the world. In the remaining of the paper, we are going to introduce our new novel classification based on the IT facilities of the science parks.

3. Methodology

In order to accomplish our proposed classification, we confronted with two different stages. First, we found related IT criteria and then categorized existing Iranian parks according to these criteria. Following is a detailed description of the two phases:

Phase 1: Identification and classification of the IT facilities
In this phase we first identified the IT facilities which can be provided by STPs for their tenants. Toward this aim, we first investigated different science parks' web sites in the world to find any differentiated IT services offered by them. We also contacted to some of these parks through e-mail, to figure out the IT facilities they provide for the tenants in some more details; but most of them refused to answer our e-mails and were not eager to share their information with others. Additionally, we conduct a comprehensive study of different information technologies in the world specially in the field of networking and communication.
Besides these researches on the Internet, as a close relation to some of the parks and incubators managers, as well as, some of the tenants' personnel, we were informed of some practical deficiencies which they are facing with in practice. They also assist us with offering the practical solutions to these shortages.

Phase 2: Evaluating the position of Iranian science parks in our taxonomy
In this phase we examined heterogeneous IT facilities that are provided by Iranian science parks. Towards this aim, assisting from Ms. Mojib the Director General of Iran's STPs and Incubators, we could figure out what kinds of IT services are provided by Iranian STPs. Finally, using the information, we applied our classification in order to evaluate the place and position of Iranian parks in our model.

4. Our proposed taxonomy

As mentioned in section 2, all the taxonomies which have been proposed up to now have some deficiencies and are not very thorough.
In this section, we are going to describe our proposed taxonomy which is based on the IT facilities provided by the STPs for their tenants.
We have divided all the IT facilities that can provided by the STPs into seven different groups which are described in the following.

4.1 Network Infrastructures

This category includes all the basic information technologies which are essential to have a reliable connection to divergent Internet resources.
Some of these basic technologies are listed in the following:

a. Using fast speed Internet lines.
b. Using WLAN or Ethernet to provide firms with Internet connection.
c. Using Uninterruptible Power Supply (UPS) in order to maintain a continuous supply of electric power for the firms.

One of the major problems of Iranian parks that results in not to have the latest network infrastructures, is the lack of energy tunnels. Using these energy tunnels which are made to conduct

different energies such as gas, electricity, telecommunications, etc would be so helpful in keeping our telecommunication infrastructures up-to-date.

4.2 Security

Since we are living in information age and the most valuable assets of majority of companies is information, science parks should apply some mechanisms in order to provide the secrecy of firms' information.
Some of these mechanisms are:

a. Providing security for all the information inside the park and preventing unauthorized agents to access the park's information.
b. Using cryptography in layers above Data Link Layer (DLL) in order to prevent firms to access each other information.
c. Creating different access levels for the personnel of the park and also the tenants, so that nobody can gain admittance to the secret information of the other firms and the park.

4.3 IT-enabling

The process of providing IT systems that would enable the business to grow and gain three important factors of efficiency, effectiveness and sustainable competitive advantage is called IT-enabling.
Some of the IT-enabling tasks that would be helpful for science parks are as follows:

a. IT-enabling the process of a firm's entrance in a park from call-for stage until admission and residence.
b. The ability of tracking the flow of doing the affairs for applicant firms.
c. The ability of online reservation of the park's shared properties like video-projector, voice recorder and etc by the firms
d. The ability of online reservation of an appointment with those who are in charge with the park.

4.4 Information Services

All kinds of services that are beneficial in storing, managing and retrieving the information are included in this category. It also contains some of the e-services that are used to spread the information through Internet or intranet such as e-catalogs and e-announcements.
The following is the list of some of the information services that are beneficial for science parks:

a. Managing the data flow inside the park or even inside the firms.
b. Keeping the firms informed of latest news.
c. The ability to search the information inside the park easily.

Content Management Systems (CMSs) and Portals are some of the most famous softwares that are used to provide their users with these information services.

4.5 Multimedia

As we go forward, the applications of multimedia features are increasing as a result of high speed networks. These technologies are so vital for scientists and firms to collaborate with each other in different branch of science.
Some of these features are as follows:

a. The ability of using Voice over IP (VoIP)
b. The ability of using video-conferences
c. The ability to conduct seminars on the World Wide Web (webinar)
d. Since one of the duties of science parks specially their incubators is training the firms' personnel, e-learning classes can play a pivotal role to carry out this duty.

4.6 Application Service Providing (ASP)

The idea of delivering a service as opposed to a product is fundamental to the operation of application service providers such as salesforce.com. In providing applications for the use of clients via the Internet on the basis of a fee for usage, clearly what is being delivered is not a product but a service. The ASP model essentially converts a software product into a software delivery service and is a paradigm shift in application delivery. ASPs are responsible for the functionality, availability and reliability of a hierarchy of underpinning components and sub-services (software, hardware, expertise, telecom providers and hardware suppliers).

Science parks as some kinds of large organizations can play the role of ASPs and provide some of the required services for their tenants. In this way they can create some competitive advantages and be more successful in attracting further firms.

Some of the services that science parks can provide for their tenants are:

a. FTP server
b. Web server
c. Mail server
d. Database server
e. Fax server
f. Administrative tools such as inventory systems, accounting systems, etc.
g. Big industrial solutions like CRM[1], ERP[2], SCM[3], etc.

It is considerable that the items 'a' to 'd' are so important to support the hosting of the firm's web sites. Since, today roughly most of the firms have a web site, providing these services by the park will have good effects in creating some competitive advantages for the park which results in more customer satisfaction.

Providing item 'e' by the parks, would be so helpful in reducing the costs of tenants, since they do not need fax machines any more.

Administrative tools are the collection of some widely used softwares such as accounting and inventory softwares. Since nearly all the tenants are requiring the administrative softwares, providing these softwares by means of parks would be greatly beneficial in decreasing the tenants' costs.

Industrial solutions such as Customer Relationship Management (CRM) are such expensive softwares that even most of the parks can not afford buying. So what do we mean by putting these softwares in this category?

Although buying the services from ASPs are more advantageous than buying the softwares, the solutions are such expensive that small- and mid-sized firms can not afford even renting the services. So, in order to providing the firms with these expensive solutions, science parks can make some contracts with these big ASPs and accommodate the tenants with these solutions.

4.7 Intellectual Property Services

As we are moving from industrial economy towards digital knowledge-base economy, industrial products are gradually substituting with high-tech products which are outcome of innovation. These high-tech products, in contrast to industrial ones, can be easily copied by the competitors. The existence of intellectual property (IP) rights is exactly because of these problems that we are facing with in the new economy.

In these situations, science parks could differentiate themselves from the others by providing miscellaneous IP related services.

Some of these services are explained in the following:

a. The price of registering a patent in the world or even in the county is so high and usually they have long procedures to accept an invention as a patent. Because this process is so time-consuming and expensive, and also this registration is vital for the firms in order to prevent their products to be copied by the others, STPs can support their tenants by

establishing an IP office in order to award them the required money as a loan or grant and also assist them with doing the official tasks of the process.

b. One of the dominant problems that software companies are facing with is to protect their products from being copied by the others. To gain this goal, they ought to spend a large amount of money to have their products protected using software or hardware locks. Offering these services will be so beneficial for the tenants and would have high impacts on parks so that they can distinguish themselves from the others.

As it is clear this category is not completely related to the IT facilities that science parks should provide for their tenants, but because of its significance in today economy we included it in our taxonomy.

5. Prioritizing the IT facilities

The diversity of IT facilities creates a difficult task for STPs to prioritize the services in order to include them in their strategic plans.
To solve this problem, we have prioritized the IT facilities in three different groups which are illustrated in Figure 2 and are explained in the following:

a. **Essential IT facilities:** this group contains the basic IT facilities which are vital for science parks, so that they can gain the minimum satisfaction of their tenants.

b. **Important IT facilities:** the services which are included in this group are so important in increasing the efficiency and effectiveness of the tenants.

c. **Desired IT facilities:** there are some kinds of service which are not so significant for a park, but providing them for the tenants will create sustainable competitive advantages for the park, so that the park can discriminate itself from the others. These services are included in the "Desired IT facilities" group.

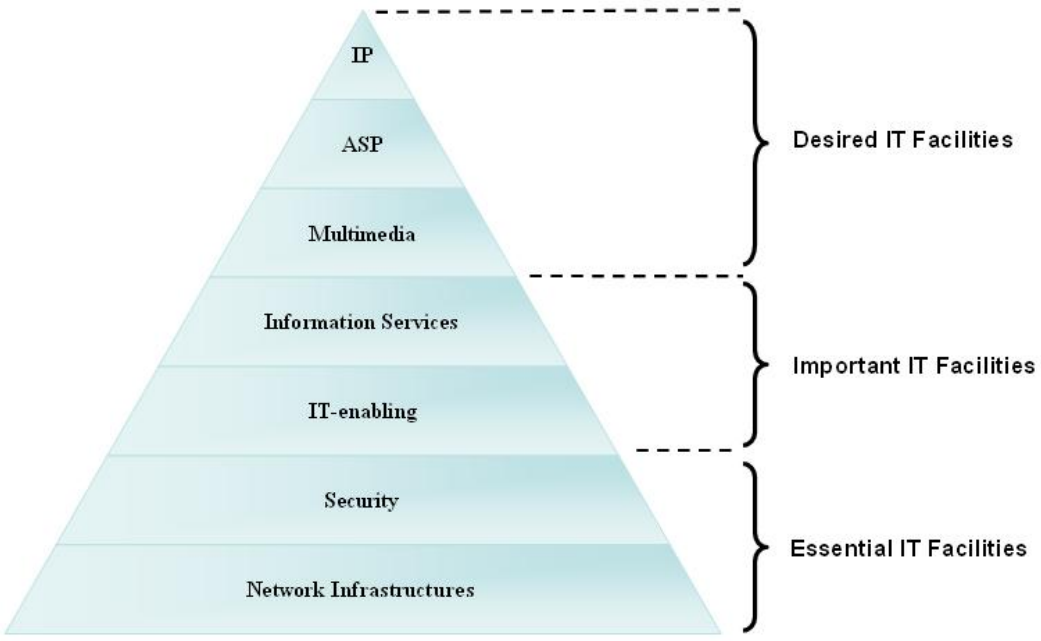

Figure 2. Classification of IT facilities based on the importance

6. The position of Iranian parks in our model

In this section, we briefly scan the position of Iranian STPs in our model. Table 3 illustrates the general position of Iran science parks in using different IT facilities.

As it is obvious in the table, the network infrastructures in Iranian parks are not so bad, but we still have a long way to reach the developed countries. In using security mechanisms, unfortunately we have not good situation and park's managers do not pay enough attention to this field; in fact tenants themselves are responsible to provide the required security of their own.

IT-enabling have not been paid enough attention in our parks and if we want to increase our efficiency and effectiveness of our firms, we have to be more attentive to this field.

Information services such as Content Management Systems (CMS) and portals have been noticed in recent year, but it still requires improving to satisfy the tenants' requirements.

Multimedia applications are not broadly used in our science parks as a result of not having good infrastructures and Internet speed. Finally, in the case of ASPs and IP services almost nothing is done in Iranian parks. This is mostly because of not to abided by the IP laws in our country.

Current position / IT facilities	very low	low	medium	high	very high
Network Infrastructures			✓		
Security		✓			
IT-enabling	✓				
Information Services		✓			
Multimedia		✓			
ASP	✓				
IP Services	✓				

Table 2. The position of Iranian parks in providing different IT facilities

7. Conclusion

In this paper we first reviewed some of the recent works on the classification of STPs. We then proposed a new model to categorize science parks in different levels, based on the IT services they provide for their tenants. Finally, after introducing our proposed classification method, we applied it on Iranian science parks in order to analyze their position in exploiting the newest IT facilities to satisfy their tenants' needs and also gain some competitive advantages relative to the other parks in the world.

We believe this classification has two important advantages compared to preceding taxonomies. First, it is not restricted to any special country and can be applied in all countries in the world and for all types of parks. Second, as we are moving toward the "New Economy" the significance of IT facilities will be highly increasing and this classification would be a great help in evaluating the science parks. Our proposed taxonomy would be helpful for both, those who are in charge with STPs, and the ones who are looking for an excellent park to reside their firms in according to their needs.

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[1] Customer Relationship Management
[2] Enterprise Resource Planning
[3] Supply Chain Management