Three Stages of Science Park Development: the Case of Daedeok Innopolis Foundation

Oh, Deong-Sung¹, An, Gi-Don²

ABSTRACT:
In this paper, we attempt to identify three stages of science park development by analyzing Daedeok Innopolis Foundation for past forty years since 1970s. Prior to case study, the types of science park development and their functional structures were reviewed. Three steps of science park development are identified: science park, technopolis, and innovation cluster. There are 4 main functions (R&D, Business, Management, and Infrastructure. We found that The Daedeok Innopolis Foundation has experienced three clear phases of Science Park development. The Daedeok Innopolis Foundation played a role of Science Park at the initial stage by functioning as a national hub for development of science and technology. It functioned as Technopolis at the middle stage by providing a total system for innovation and technology commercialization. It currently functions as Regional Innovation Cluster at the mature stage by providing the center of business excellence on high-tech industry in the global science. It has made the great effects on the regional economy. We expected this paper to provide the guideline of technical assistance and policy making at preparing the science parks in developing countries. Particularly this paper will make a contribution to enhance the future oriented way of sustainable science park development.

KEYWORDS: Science Park, Technopolis, Innovation Cluster, Regional Economy, Daedeok Innopolis Foundation,

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1. Introduction

The science park movement, which is concerned with fostering both technology innovation and commercialization, has been growing since the 1950s. Today, this movement includes a variety of projects that encompass incubators and innovation centers, science, research, technology and hi-tech parks, technopolis and science cities, and no doubt other names will emerge in time for similar projects intended to serve essentially the same process of supporting technology transfer.

In today’s knowledge-based economy, science park is a regional innovation strategy that generates sustained and propulsive economic activity through the creation and commercialization of new knowledge. These science parks are critical ingredients for successful ‘knowledge-based economy’ as well as they are instruments for such innovation-oriented regional policy. The emphasis on the stimulation of high-tech industry through science parks and other initiatives by so many countries around the world is based on the assumption that technological innovation leads to economic growth (Simmie et al., 1993). There are, in particular, important issues concerning the dynamics of their creation and support that need to be addressed and better understood. The most important is how effective a science park can be as an instrument of regional innovation policy and for stimulating technology-led economic development.

In Republic of Korea, the science park development began to gain momentum in the 1970s when the Daedeok Science Town (Daedeok Innopolis since 2004) established as a national R&D center. In particular, The Daedeok Innopolis Foundation were intentionally created as an engine of enhancing national competitiveness of high technology and economic prosperity through the agglomeration of research institutes in a planned science city. It brings together many national and regional development policy efforts from the last 40 years to achieve a technology-based economic growth and regional innovation. In addition, the regional innovation policy targeting for innovative cluster is one of critical instruments to achieve sustainable development through networked collaboration between HEIs, research institutes, industries and government. It is highly evaluated that The Daedeok Innopolis Foundation is playing a crucial role as a regional platform for comprehensive approach of technology-based regional development in sustainable context.

This paper reviews three stages of science park development in the case of The Daedeok Innopolis Foundation which has 40-year experiences. In particular, the functional structure of science park development will be analyzed in terms of three different stages of development: science park, technopolis, and regional innovation cluster. Finally, this paper analyzes the effects of The Daedeok Innopolis Foundation on the regional economy.

2. Concept and Development Types of Development

2.1 Concept

Definitions of science park or technopolis development vary considerably around the world and significant variations occur even within individual countries. The essential concept however is one of spatial

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1The concept and development types of Science park is rewritten based on Oh(2009)’s paper.
development where the interface of research with commerce and industry is encouraged for the better exploitation of advanced technology. We use the term science park or technopolis in the broadest sense to denote property-based development, sometimes related to urban redevelopment, which has the objective of facilitating and promoting the growth of high-tech firms, through technology transfer and cross fertilization, in association with higher education institution (HEI) or a research centre (Porter, 1997). In the 1990s, Technopolis(or science city), a land and property-led technology policy concept which aims at spatially clustering high-tech firms and R&D organizations, have been very popular among both local, regional and national policy-makers to boost regional economic growth. In addition, they have given hopes to policy-makers in many countries to boost regional technology transfer, innovation and hence competitiveness.

Broadly speaking, science park, technopolis or regional innovative cluster aim at achieving three goals. First, the most obvious goal is to foster economic development. High-tech and innovation-led growth is regarded as absolutely necessary for maintaining and increasing competitiveness of firms, regions and nations (Malecki 1997). Second, in some countries, particularly those with over-populated and congested urban areas, building an out-of-the-way technopolis in the countryside is often seen as a way to reduce regional economic inequalities. Economic planners hoped to draw research and development out of the over-burdened capital cities by relocating their national research facilities and universities to new sites in the country and by luring firms with incentives to follow them there. Third, they aim at creating synergy between HEIs, PREs and firms in order to foster technology transfer, innovation and hence competitiveness. In the end, this should lead to creating an environment geared toward innovation. Capital and resources are naturally drawn to such a “milieu of innovation” rather than having to be relocated through central planning (Castells & Hall 1994).

2.2 The Development Types of Science Parks: Science Park, Technopolis, and Regional Innovation Cluster

Three broad categories of science park development have emerged: science park, technopolis, and regional innovation cluster. Science park or technopolis is property-based initiative which has formal links with a university or other higher educational and research institution (HEI); is designed to encourage the formation and growth of knowledge-based businesses and other organizations normally resident on site; has a management function which is actively engaged in the transfer of technology and business skills to the organizations on site. The regional innovation cluster can be defined as a specific area(s) with networked location(s), where innovating actors are concentrated and interacting, which functions as the source of innovative activities for the surrounding region, and supersedes other areas in terms of innovation competitiveness (Yim, 2002). It is a system for innovation composed of actors, process, interaction mechanism, and culture etc. innovation cluster is the unit of competition and has various advantages in science and technology knowledge production, transfer and utilization.

Within this definition of three basic development types, it is also possible to identify several sub-forms which complement other initiatives designed to stimulate a more productive relationship between industry and academia. Science Park and Technology Parks are defined a "larger areas of land suitable for knowledge-based firms of different sizes and stages of development, usually, though not necessarily in
landscaped surroundings” (Currie, 1985). The planning framework should be sufficiently flexible to permit ‘light manufacturing’. A Science Park is an organization managed by specialized professionals, whose main aim is to increase wealth of its community by promoting the culture of innovation and the competitiveness of its associated business and knowledge-based institutions. To enable these goals to met, a Science Park stimulates and manages the flow of knowledge and technology amongst universities, R&D institutions, companies and markets; it facilitates the creation and growth of innovation-based companies through incubation and spin-off processes; and provides other value added services together with high quality space and facilities.

The technopolis emphasizes the need for a balanced approach to high technology development. Instead of only focusing on technology it involves the creation of new settlement, complete with research park, new universities, technology centers, housing and cultural facilities (Tatsuno, 1986). Masser (1991) has pointed out that technopolises are larger in scale and often linked to the development of infrastructure and facilities on the new town model, whereas science parks are more limited in scope. Technopolises also tend to be more production oriented than science parks and have both national and regional objectives. The national and technological objectives are to offer to high-tech industries adequate industrial land and an environment suitable for creative research. These resources have become scarce in the major metropolitan areas. Consequently, the regional and technological objective is to promote technological development in less developed areas. For this purpose, physical, scientific and institutional infrastructure is developed in a decentralized pattern by a combination of measures taken at the local and regional levels and by national government (Stoehr and Poeninghaus, 1992).

Regional innovation cluster is the unit of competition and has various advantages in science and technology knowledge production, transfer and utilization. Innovation networking in cluster aims to enhance the innovative capacity and foster the strategic industry for regional and national competitiveness through the interaction and close linkage among government, R&D center, research institutes, HEIs, high-tech industry, partnership of universities and industries, commercialization, marketing and financial support. There are five key success factors in innovation cluster as following; specialized professionals to manage, active community participation in innovation programs, regular discussion forums, research and industry engagement, access to value-added services. And also, Porter(1998) identified three advantages to locating close to one another in cluster. First, it can share the cost for certain collective resources among several firms, particularly to the cost of establishing the wanted infrastructure. Second, it can develop a local labor market for specialized skills. Third, firms can leverage their close proximity and reduce costs of inter-firm transactions and shipments, or interaction costs for co-located trading partners.

<<Insert Table 1>>

Table 1 summarizes the key features of science park, technopolis, and regional innovation cluster with respect to their nature and physical characteristics. And also, the development aspects are summarized with the structure in relationship and linkage, the activity in R&D and the network among heterogeneous R&D activities.

3. Three Stages of Science Park Development:
Case Study – The Daedeok Innopolis Foundation, Korea

3.1 Framework
In this chapter, we attempt to suggest a creative model of science park based on the experience of The Daedeok Innopolis Foundation. Conceptual framework is necessary to identify the development features of science park. In particular functional structure of components can be analyzed in accordance of different development steps: science park, technopois and innovation cluster.

The analysis consists of four steps:
Firstly, the background and purpose of science park’s development are reviewed.
Secondly, the functional structure which is characterized with each science park model is identified.
Thirdly, the relationship between each function and component will be analyzed. The components of key role which can give synergy effect for other components will be checked.
Forthly, the strategy of creative science park development will be suggested in conclusion.

3.2 The initial stage: Science Park model

The development feature of Daedeok Science Town at the initial stage shows us the model of science park. As a national hub for development of science and technology, main objectives in the initial stage of the Science Park are:
- Constructing infrastructure: Designing, developing, and managing the Science Park. Also includes forming connections with other cities and regulating development of the Science Park (Regulating green areas, building-to-land ratio, floor space index, and etc).
- Managing and operating the Science Park: Harmonizing R&D facilities, amenities, and welfare facilities with each other. Also includes maintaining the balance between supply and demand in the Science Park.
- Constructing institutional infrastructure: An institutional structure to regulate environmental pollution, to activate business and R&D activities, and to enhance the convenience of residents should be established.

This science park model contains three main functions: R&D, Business and Infrastructure. Management is only limited to infrastructure-related service. In terms of research & development, research and education were led by research centered HEIs. Training of experts in basic science was improved. Public research institutes focused on conducting national R&D projects and constructing national R&D infrastructure. They also focused on the construction of a national framework of science and the development of strategic industries with a long range vision. Private R&D institutes formed a hierarchical relationship with their mother firms and concentrated on R&D related to their mother firms. They focused on building R&D infrastructure and R&D activities. In this stage, the commercial potential of R&D results in basic science or engineering from research centered HEIs promoted the construction of the Science Park: Business incubation centers and technology exchange centers were built in HEIs and R&D institutes to support technology commercialization. Collaborative R&D also began. R&D experts trained in research concentrated HEIs led technology commercialization activities.

In terms of Business & networked Entrepreneurship, the Daedeok Science Park focused on non-industrial basic science activities in the initial stage. Thus entrepreneurship activities were barely present at this stage. Business incubation activities were barely supported in this stage. The only business incubation space provided were labs in HEIs. Business incubation was limited to business start-ups in labs of HEIs. In order to support business start-ups, a systemized business incubation system is required for example,
Pre-Incubation systems, TBI projects in HEIs. The venture capital methods in this stage were mainly Angel Funds, which is a type of Risk Financing. Funds were mainly provided to venture firms by individual investors (Risk Financing). Thus, venture capital services were barely existent. Only lab business start-ups in research concentrated HEIs were supported in this stage. Administrative networks among public research institutes were formed. R&D activities were mostly conducted with government aid. Thus, independent networks between institutes were barely existent. More networks should be formed among firms, HEIs, and research institutes to promote R&D activities and to support business incubation. In this stage, technology commercialization and venture activities were mainly conducted in labs located inside research institutes and HEIs.

Main infrastructure in the initial stage, Science Park was limited to R&D related facilities such like R&D center, HEI etc, which did not contain industrial functions. Initially this park was designed as a research and education city. A legal structure to regulate land-use should be established. The Science Park was initially built as a national science and technology city, so business activities were not recognized in the initial stage. Legal structures or institutes that manage business facilities did not exist in this stage. The function of Science Park Management Office includes designing the Science Park, selecting occupying institutes of the Science Park, and other management functions. Education, research, and residential facilities were harmonized with each other in the Daedeok Science Town.

<<Insert Table 2>>

In summery, main functions are R&D, Business activities and Infrastructure. The management is limited to maintenance service. The components of key role are HEIs, National R&D Center in R&D function, Spin-offs of R&D labs in Business function and management office in Infrastructure function.

3.3 The middle stage: Technopolis model

At the middle stage of The Daedeok Innopolis Foundation development shows us the technopolis model. The Technopolis model is a total system for innovation and technology commercialization. This model is operated in the composition of four main functions and their components.

<<Insert Figure 2>>

In this stage, HEIs and research institutes actively supported business incubation activities: containing legal support, constructing infrastructure (business incubation center, and etc). Cooperation between the Science Park and the local government, which governs the city where the Science Park is located, is important for collaborative activities. In order to expand R&D activities into technology commercialization activities, R&D capacity of the Science Park was enhanced. In addition industrial areas were expanded next to Science Park. At the same time, various infrastructures were expanded in the Science Park, a legal structure to efficiently manage and operate the infrastructures was established. Venture firms were created and the roles of HEIs became more important in this stage. All HEIs, including research centered HEIs and local engineering HEIs, conducted technology commercialization and collaborative research with firms, research institutes, and HEIs.

The main features of Science Park development at initial stage are as follows. In terms of Research & Development, HEIs became more important, since they are the source of venture firm start-ups. Various local HEIs moved into the Science Park and contributed in collaborative R&D activities with other firms and research institutes. HEIs mainly conducted research projects offered by the government with the help from public research institutes. With research
centered HEIs and local HEIs participating actively, R&D activities in the Science Park were enhanced; the groundwork for venture firm start-ups was established. Research projects given by the government were conducted by HEIs. Public research institutes led collaborative research projects with industries and HEIs, conducted research contracts offered by private firms, and etc. Commercialization of research results began in public research institutes; promoted start-ups of venture firms. As HEIs’ and firms’ R&D activities increased and expanded, public research institutes’ functions increased and expanded. Public research institutes supported the creation of venture firms by establishing business incubation centers, and etc. In government affiliated research institutes, national R&D projects and collaborative R&D projects were conducted. In the process, technology commercialization, technology transfer, spin-off activities occurred. In order to support these activities, support systems such as business incubation systems were established.

In terms of Business & networked Entrepreneurship, a system to utilize research results from research institutes and HEIs in order to support potential entrepreneurs and venture firms is necessary. Business incubation activities should be expanded from a small number of public institutes and HEIs to various local institutes. Also, business incubation activities should be integrated and diversified to promote regional development. There should be an integrated support system for venture firms, which includes customized business incubation, specialized collaborative networks, venture communities, venture capital programs in order to support venture firms efficiently and flexibly.

In terms of Management & Globalization, the management and operation of the technopolis should become more professionalized. The management and operation services should include education programs which are developed by public institutes, financial aid for venture firms, marketing services, institutional support, various equipments, facilities, and etc. Technology Commercialization was the core topic of education programs: Technology marketing, technology management, technology commercialization, advertisement of products, and etc. Financial aid was provided to venture firms in order to help venture firms to settle down and make progress. A financial aid system that focuses on supporting venture firms was established by the central government. Local governments also adhered to the central government’s policy of supporting venture firms and their growths; the functions of business incubation centers established by local governments were enhanced to also provide financial aid. An integrated operation and management office was established instead of individual operation and management institutes. It was an integrated system that synthesizes the governance of the Science Park like management, infrastructure maintenance etc. The cooperation with local governments was taken for the sustainable development of technopolis.

As a function of Infrastructure, industrial space for venture firms and R&D facilities was expanded in order to expand early R&D activities to technology commercialization. As various infrastructures in the Science Park is expanded, a legal structure was necessary to efficiently manage and operate the facilities. A structure and the division of roles in R&D facilities, business facilities, management facilities was established. Accessibility quality of life enhanced in terms of transportation, land-use, amenities. The integration of culture and society with local residents was emphasized to make best use of mother town’s infrastructure.

3.4 The mature stage : Innovation Cluster model
At the mature stage of development, The Daedeok Innopolis Foundation takes innovation cluster model: a center of business excellence on high-tech industry in the global science. In order to establish an innovative cluster, the collaborative system among firms, HEIs, and research institutes are enhanced. Regional innovation cluster of national or local strategical industries are created in The Daedeok Innopolis Foundation. A specialized science and technology network is established to maximize innovation of science and technology. At the end, global marketing strategies were enhanced. We are trying to attract foreign institutes and foreign investment into the Science Park. In particular, a cooperation system among firms, HEIs, and research institutes was enhanced in strategic industrial fields such as IT, BT, and NT. As a result, a innovative cluster was build and collaborative R&D is actively conducted in order to conduct technology commercialization. Numerous networks among firms are created in order to support technology commercialization and business activities.

In this experts in science & technology and integrated professional training programs are required to build an innovative cluster. It is important to create clusters of related institutes to promote the growth of strategic industries. Financial aid and support in specific technologies are also important. Cooperation with international innovative clusters and global marketing strategies induces synergy effects in the development of science and technology.

In innovation cluster, pleasant residential areas and strategic high-tech industries should be harmonized with each other. In addition, the cluster was developed into an innovative cluster, which leads local innovation. Land-use should be improved to activate high-tech R&BD activities. A systematic and integrated structure of R&D facilities, business facilities, and management facilities are required in order to promote the development of high-tech strategic industries. A multi-purpose site was established in The Daedeok Innopolis Foundation to attract strategic industries, foreign advanced research institutes, and foreign research centered firms into The Daedeok Innopolis Foundation. An international support infrastructure was established to enhance global competitiveness.

The main features of Science Park development at mature stage are as follows.

As a function of Research & Development, research centered HEIs led R&D activities in national strategic industries. Core science fields such as IT, BT, and NT fields were mainly researched in order to increase national competitiveness. Through collaborative researches among HEIs, research institutes, and industries, technology commercialization was conducted. HEIs' roles and functions were diversified. In order to maximize the efficiency of technology commercialization activities, R&D activities in specific fields were supported by public research institutes. By creating clusters of strategic industries, technology can be accumulated. Continuous R&D activities and the formation of strategic industry clusters is required for technology innovation.

In terms of Business & networked Entrepreneurship, an institutional system and infrastructure was established to support entrepreneurship activities. This led to the construction of an innovative cluster. Potential entrepreneurs in strategic industries were discovered and supported to build an industrial cluster and a Regional Innovative System. Business incubation services, including the provision of space and facilities, institutional structures, and etc were improved. As a result, venture firms became more active. Professional support services such as business consulting, technology marketing, and etc were provided as part of business incubation programs. Business incubation programs were customized and
divided into three stages. These systemized business incubation programs efficiently supported the settle down of venture firms. Business incubation programs supported venture firms to settle down and ultimately, the venture firms contributed to the establishment of an innovative cluster.

In terms of Management & Globalization, a regional innovation system should be established by the government. An education department should be established in the RIS in order to provide a customized education program for different regions. The customized education programs should focus on technology commercialization and business incubation. Education programs in specific fields or retraining programs should also be diversified.

Consistent education programs should be offered by education institutes such as the University of Science and Technology, The Technology Management Graduate School, Patent and Law Graduate School, and etc. In order to establish an innovative cluster, financial aid is necessary in high tech fields. Technology marketing has to be supported in different technology clusters. Financial aid should be provided to specialized or advanced technologies.

Cooperation among different technology clusters is necessary. Cooperation networks were created among related institutes in the Science Park. These networks were built by the management Office of the Science Park and local governments. Clusters were built inside the Science Park and cooperation between domestic clusters and foreign clusters was encouraged.

In terms of Infrastructure, Land-use should be more specialized and integrated to suit foreign firms and to establish an innovative cluster. Residential areas and industrial areas should be harmonized in an innovative cluster. An infrastructure for technology commercialization and expert training should be expanded. A supporting organization should be built to provide cooperation opportunities among institutes in the Science Park, technology commercialization, marketing, and consulting. Amenities and education facilities should be built to suit residents of the Science Park. R&D facilities should be actively provided in order to promote the growth of strategic industries. In order to establish an innovative cluster, advanced research institutes and research concentrated institutes, which are outside of the country, should be attracted into the Science Park by providing them space and facilities (Hutchinson research institutes and other facilities for foreign institutes). In order to support venture firms, a lending program was established to lend business incubation space and facilities; The Business Hub Center, The Integrated Research and Production Center, and etc. The lending programs should be flexible to cope with various demands from venture firms.

4. The Effects of The Daedeok Innopolis Foundation

There are nearly twice as many institutes (1266) in 2010 as those (742) in 2005. Among these, 30 government-funded research institutes and 1179 private businesses are operating. As Table 2 shows, it is clear that the growth of private firms has led to increase of institutes in DI. The number of private firms has risen by almost double digits except 2009 year when the world economy experienced the global economic crisis.

In 2010, the total employment was 55,614 of which 24,434 are researchers and engineers and 31,180 are

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2 The effects of the DIF is rewritten based on the paper of Kim & An(2012).
working on R&D supporting organizations in DI. The number of researchers has increased by 13%, and 19% in 2009 and 2010 respectively.

DI has improved the capability of its R&D activities since 2005 when DI was redesigned as DI. As a result, DI has experienced the rapid increase in high numbers of domestic and international patents as well as technology transfers. The patent has been one of major driving forces in DI by strengthening DI's competitiveness as well as bridging commercialization. The number of applied patents increased 488% from 1997 to 2002 and that of enrolled patents rose 388% during the same period. The reason is that the number of venture firms dramatically rose in DI because the government changed the law in 1999 in order to bring venture businesses within DI. Even though venture businesses started in 1993 around DI, these businesses were not able to be located within the park due to the Law for Daedeok Science Town Management (Park, 2004). Because this law was widely known as resulting in weak spin off effects between R&D and manufacturing, the government changed this law in 1999 in order to bring venture businesses into the park.

The technology transfers have continually increased since 2005, except when the global economics crisis happened in 2009. The transfer fees have rapidly increased by 111% from 2005 to 2010. Especially, the technology transfers to venture business were 80% of total technology transfers in DI. The increase in the number of venture businesses and technology transfers has been the key factor of growth in DI. The number of venture business which has a venture certificate increased up to 589 in 2010. In addition to new venture businesses, enlarging industrial contributed to the rapid increase in DI. Daejeon metropolitan government has built two high-tech based industrial parks near to DI in order to generate spin-off effects from the research results of DI (Daedeok Science Town Management Office, 2002b). As a result, the number of ventures registered in the Korea Stock Exchange (KSE) has increased from 11 in 2005 to 24 in 2010. DI is able to improve an innovative cluster by connecting activities like technology transfers from R&D to production activities.

### Table 8. Technology Transfers and Fees

<table>
<thead>
<tr>
<th>Year</th>
<th>Transfers</th>
<th>Fees</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>778</td>
<td>110,319</td>
</tr>
<tr>
<td>2009</td>
<td>910</td>
<td>109,394</td>
</tr>
<tr>
<td>2008</td>
<td>974</td>
<td>95,723</td>
</tr>
<tr>
<td>2007</td>
<td>815</td>
<td>77,798</td>
</tr>
<tr>
<td>2006</td>
<td>723</td>
<td>61,205</td>
</tr>
<tr>
<td>2005</td>
<td>611</td>
<td>52,408</td>
</tr>
</tbody>
</table>

Source: Kim, Sang-Tae, Gi-Don An. (2012)

### 5. Conclusion

In this paper, we attempt to identify the creative model of science park development based on the experience which is accumulated in The Daedeok Innopolis Foundation for past forty years since 1970s. Prior to case study, the types of science park development and their functional structures were reviewed. They are as following:

- Three steps of science park development are identified: science park, technopolis, and innovation cluster.
- 4 main functions (R&D, Business, Management, and Infrastructure) and their detailed components are suggested through the analysis of 11 international experiences including The Daedeok Innopolis Foundation.

With these consideration in mind, we attempt to analyze the case of The Daedeok Innopolis Foundation Development based on the conceptual framework including functional structure of creative Science Park.
development. Three clear phases of Science Park development were identified in The Daedeok Innopolis Foundation.

- Science Park at initial stage: a national hub for development of science and technology
- Technopolis at middle stage: a total system for innovation and technology commercialization
- Regional Innovation Cluster at mature stage: center of business excellence on high-tech industry in the global science.

The detailed analysis according to four main functions (R&D, Business, Management and Infrastructure) and 19 components explains how science park can work together with its own functional structure and which components can play a vital role for successful science park development and regional innovation.

We expected this paper to provide the guide line of technical assistance and policy making at preparing the science parks in developing countries. Particularly this paper will make a contribution to enhance the future oriented way of sustainable science park development.

ACKNOWLEDGMENTS

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REFERENCE


The Daedeok Innopolis Foundation. (2010). The Internal Statistical Materials


Web sites

www.innopolis.or.kr
Table 1. The Development Types of Science Parks: Science Park, Technopolis, and Innovative Cluster

<table>
<thead>
<tr>
<th>Types</th>
<th>Features</th>
<th>Model</th>
</tr>
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</table>
| **Science Park: Property-based Initiative** | - Formal links with a university or other higher educational and research institution (HEI)  
- Designed to encourage the formation and growth of knowledge-based businesses and other organizations normally resident on site  
- Management function which is actively engaged in the transfer of technology and business skills to the organizations on site | ![Science Park: New Settlement focused on R&D](image)                                                                                                                                                                                                                                      |
| **Technopolis: Urban development** | - Emphasizes the need for a balanced approach  
- Instead of only focusing on technology it involves the creation of new settlement, complete with research park, new universities, technology centers, housing and cultural facilities (Tatsuno, 1986)  
- Larger in scale and often linked to the development of infrastructure and facilities on the new town model  
⇒ whereas science parks are more limited in scope (Masser, 1991; Oh, 1997)  
- More production oriented than science parks have both national and regional objectives | ![Technopolis: New Town development including mass production](image)                                                                                                                                                                                                                   |
| **Regional Innovation Cluster: Regional networking** | - To develop a network building of available intellectual, innovative and entrepreneurial resources.  
- To use these resources effectively Innovation cluster, that is, a favorable business, social, and political environment, is necessary to effectively utilize the intellectual, innovative, and entrepreneurial resource.  
- Provided with an applicability for development policy and insight to regional competitiveness  
- Regional and national competitiveness is often decided by the innovation clusters | ![Regional Innovation Cluster](image)                                                                                                                                                                                                                                                  |

Source: Oh, Deog Seong. (2009). Creative Model of Science Park Development
Figure 1. The Framework of Science Park

![Science Park Model Diagram](image)

Source: Oh, Deog Seong. (2009). Creative Model of Science Park Development

Table 2. Functional Features of Science Park at Initial Stage

<table>
<thead>
<tr>
<th>Function</th>
<th>Main Features</th>
<th>Key Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>R&amp;D</td>
<td>- HEIs that lead advanced science technology R&amp;D.</td>
<td>HEIs, National R&amp;D Center</td>
</tr>
<tr>
<td></td>
<td>- Government affiliated research institutes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>: In order to increase national science and technology capacity,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>major R&amp;D projects were supported by the government.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(government affiliated institutes)</td>
<td></td>
</tr>
<tr>
<td>Business activities/technology commercialization</td>
<td>- Firms that originated from research institutes in advanced science fields.</td>
<td>Spin-offs of R&amp;D labs</td>
</tr>
<tr>
<td></td>
<td>- Venture firms that originated from labs in HEIs or research institutes (research centered HEIs).</td>
<td></td>
</tr>
</tbody>
</table>
**Infrastructure**

- Management departments in HEIs or research institutes.
- A special management institute, which is established by the central government, managed and operated the Science Park.
→ An independent management institute is established.
- The Science Park should be managed, designed, and developed by the central government.

Source: Oh, Deog Seong. (2009). Creative Model of Science Park Development

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**Table 3. The Functional Features of Science Park at the Middle stage**

<table>
<thead>
<tr>
<th>Function</th>
<th>Main Features</th>
<th>Key Role</th>
</tr>
</thead>
</table>
| R&D      | - Active Collaborative research programs among industries, HEIs, and research institutes  
               - Enhancing local R&D support capacity.                                               | Collaboration among firms, HEIs, and research institutes |
### Business activities/ technology commercialization
- Various business incubation centers were promoted by active technology commercialization and sound entrepreneurship.
- Venture activities and technology commercialization activities of venture firms or middle sized firms are supported by local governments.

### Management
- A multi-functional office take job to cope with the expansion of the Science Park.
- To control the surrounding area of the Science Park, the institute collaborated with the local government to connect the activities of the Science Park with local innovation.
- The role of the local government was expanded to develop venture firm areas, establish various support institutes and etc for local economic prosperity, to encourage private firm investment and participation.

### Infrastructure
- Local government's support in business activities, R&D activities, management activities/ Multi-functional management institute

Source: Oh, Deog Seong. (2009). Creative Model of Science Park Development

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**Innovative Cluster Model**

A Center of Business Excellence on High-tech Industry in the Global Scene

[Diagram of Innovative Cluster Model]

Source: Oh, Deog Seong. (2009). Creative Model of Science Park Development
### Table 4. The Functional Features of Science Park at the Mature Stage

<table>
<thead>
<tr>
<th>Function</th>
<th>Main Features</th>
<th>Key Role</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>R&amp;D</strong></td>
<td>- An innovative cluster to be created to promote the growth of strategic industries</td>
<td>Collaboration among firms, HEIs, and research institutes</td>
</tr>
<tr>
<td></td>
<td>- The collaborative network among firms, HEIs and research institutes is enhanced.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Local governments should actively support the creation of innovative clusters.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Regional innovative projects are conducted by central and local governments.</td>
<td></td>
</tr>
<tr>
<td><strong>Business activities/ technology commercialization</strong></td>
<td>- A support system for business incubation activities: in addition to providing business incubation space, technology support, marketing support and other professional support was provided.</td>
<td>Strategic industrial projects led by local governments</td>
</tr>
<tr>
<td></td>
<td>- Clusters of strategic industries are created by the cooperation between science park and local governments.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Business activities such as technology marketing, technology commercialization, and technology transaction are managed by specific centers of regional innovation.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- The Techno-park was established as the core of regional platform.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- The Strategic Industry Planning Team prepared future oriented strategy.</td>
<td></td>
</tr>
<tr>
<td><strong>Management</strong></td>
<td>- Integrated education programs to train R&amp;D experts and to support professionals: specialized education programs, customized education programs and etc.</td>
<td>Global business infrastructure (management facilities, local governments, and international organizations)</td>
</tr>
<tr>
<td><strong>Infrastructure</strong></td>
<td>- Land-use system to promote business activities and R&amp;D activities in the innovation cluster: clusters of strategic industries, multi-purpose sites and etc.</td>
<td></td>
</tr>
</tbody>
</table>

Source: Oh, Deog Seong. (2009). Creative Model of Science Park Development
Table 5. The Performance of The Daedeok Innopolis Foundation

<table>
<thead>
<tr>
<th></th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>total</td>
<td>742</td>
<td>843</td>
<td>977</td>
<td>1,059</td>
<td>1,089</td>
<td>1,266</td>
</tr>
<tr>
<td>Growth Rate(%)</td>
<td>13.6%</td>
<td>15.9%</td>
<td>8.4%</td>
<td>2.8%</td>
<td>16.3%</td>
<td></td>
</tr>
<tr>
<td>public research institutes</td>
<td>21</td>
<td>21</td>
<td>28</td>
<td>28</td>
<td>29</td>
<td>30</td>
</tr>
<tr>
<td>Growth Rate(%)</td>
<td>0.0%</td>
<td>33.3%</td>
<td>0.0%</td>
<td>3.6%</td>
<td>3.4%</td>
<td></td>
</tr>
<tr>
<td>private firms</td>
<td>687</td>
<td>786</td>
<td>898</td>
<td>980</td>
<td>1,006</td>
<td>1,179</td>
</tr>
<tr>
<td>Growth Rate(%)</td>
<td>14.4%</td>
<td>14.2%</td>
<td>9.1%</td>
<td>2.7%</td>
<td>17.2%</td>
<td></td>
</tr>
<tr>
<td>others</td>
<td>34</td>
<td>36</td>
<td>51</td>
<td>51</td>
<td>54</td>
<td>57</td>
</tr>
<tr>
<td>Growth Rate(%)</td>
<td>5.9%</td>
<td>41.7%</td>
<td>0.0%</td>
<td>5.9%</td>
<td>5.6%</td>
<td></td>
</tr>
</tbody>
</table>

Source: Kim, Sang-Tae, Gi-Don An. (2012)

Table 6. The Employment of The Daedeok Innopolis Foundation

<table>
<thead>
<tr>
<th>Year</th>
<th>Researchers(A)</th>
<th>R&amp;D supporting Employees</th>
<th>Total Employment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Doctors</td>
<td>Masters</td>
<td>Others</td>
</tr>
<tr>
<td>2010</td>
<td>9,055</td>
<td>9,736</td>
<td>5,643</td>
</tr>
<tr>
<td>2009</td>
<td>7,661</td>
<td>8,191</td>
<td>4,670</td>
</tr>
<tr>
<td>2008</td>
<td>6,783</td>
<td>7,253</td>
<td>4,173</td>
</tr>
<tr>
<td>2007</td>
<td>6,800</td>
<td>7,669</td>
<td>4,327</td>
</tr>
<tr>
<td>2006</td>
<td>6,495</td>
<td>9,145</td>
<td>2,892</td>
</tr>
<tr>
<td>2005</td>
<td>6,236</td>
<td>7,561</td>
<td>2,962</td>
</tr>
</tbody>
</table>

Source: Kim, Sang-Tae, Gi-Don An. (2012)

Table 7. The Research outputs of The Daedeok Innopolis Foundation

<table>
<thead>
<tr>
<th>Year</th>
<th>Patents</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Applied</td>
</tr>
<tr>
<td></td>
<td>Domestic</td>
</tr>
<tr>
<td>2010</td>
<td>10,525</td>
</tr>
<tr>
<td>2009</td>
<td>8,818</td>
</tr>
<tr>
<td>2008</td>
<td>8,480</td>
</tr>
<tr>
<td>2007</td>
<td>7,065</td>
</tr>
<tr>
<td>2002</td>
<td>7,447</td>
</tr>
<tr>
<td>1997</td>
<td>1,376</td>
</tr>
<tr>
<td>1996</td>
<td>1,082</td>
</tr>
<tr>
<td>1995</td>
<td>1,115</td>
</tr>
</tbody>
</table>

Source: Kim, Sang-Tae, Gi-Don An. (2012)