

Management and Governance Issues in the Development of Science and Technology Based Innovation Cluster¹

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Abstract--Science and Technology Park(STP) as the kind of Innovation Cluster, have been established to strengthen the national capabilities in the science and technology by many governments and universities. However, many of the government initiated STP projects do not succeed, not because of insufficient investment but because of poor management skills and right governance structure. Many governments do not pay proper attention to the management master plan compared to the attention given to hardware infrastructure building. In this paper, relevant literatures were reviewed to identify the success factors of STPs. In addition, the cases of Korean innovation clusters were reviewed and evaluated, including Daedeok Innopolis and several Technoparks. The experience of Korea shows that the right management practice and right governance structure are critical success factors for the STP development.

I. INTRODUCTION

In today's innovation-based economy, science and technology are the key factors in determining one's national industrial competitiveness. Thus many governments try to promote the S&T development and innovation activities by various methods. One of the effective science and technology policy is to build science and technology parks. Now it is well understood that the innovation process – starting from R&D to technology commercialization – is more active in the place where the innovation actors – university, industry and research institute - are at close distance as are in S&T parks. S&T parks can be effective innovation policy because such a cluster provides the opportunity for easy access to the information, knowledge, capital and human resources and chance for better innovation.

An innovation cluster is a networked group of innovation actors and location(s), where the actors are creating economic and technological values by interacting, competing and collaborating with other actors in innovation process, which functions as the source of innovative activities for the region/nation, and has global competitiveness ([1], [2], [3]).

Currently there are many science and technology parks in the world. Even though the names and characteristics are different, the science and technology parks can be defined as the kind of innovation cluster in terms that they host many innovation actors together at the certain close area and they work as the critical players in one's regional – even national – innovation system. As we can see the growing number of

S&T Parks (STPs), many countries are trying to establish successful innovation cluster as the national agenda. However, the government policies often fail because they ignored the development and success factors of innovation cluster ([5]).

In this paper, the development pattern and success factors of innovation clusters are identified. And the experience of Daedeok Innopolis and several Technoparks are analyzed accordingly. Finally, the conclusion was drawn and some innovation policy implications were made for the development of successful innovation clusters, especially for the developing countries.

II. CONCEPTUAL FRAMEWORK

There are many reasons why the innovation cluster receives so much attention from the policy makers. First of all, the closeness of innovation actors at certain area not only lowers the transaction cost for the information, knowledge, and human resources, but provide often the better opportunity for the innovation business. So the innovation cluster has various advantages in S&T knowledge production, transfer, and utilization compared to other region. Innovation cluster is the unit of completion is an innovation cluster based on certain geographical region. Rather than a nation as a whole, the innovation cluster like Silicon Valley is leading the competitiveness of region. National competitiveness is often decided by innovation cluster(s). From the policy maker's point of view, it is well defined clear target for the policy compared to whole national innovation system.

Innovation cluster are classified by various criteria such as origin, focused areas, owner, regional perspective and so on. Of all the classification, it is important to know whether the innovation cluster was formed naturally or artificially. If it is built naturally, it has all the conditions and factors to survive or grow without government support. For instance, the Silicon Forest, Silicon Valley, and Milano Fashion Cluster have all grown naturally without strong government help or subsidy. Since many innovation clusters (STPs) are built and promoted by government, it is important to find out how the natural innovation cluster was started and what the patterns of development are.

As the Silicon Valley case shows, the critical factor for the innovation cluster is the factors of science and technology capability in the region such as R&D manpower, research center, and excellent university and so on. An innovation cluster starts to be formed when there is an excellent technological output and its commercialization was done successfully. As the success case emerges, more and more

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innovation resources are being attracted to that location and it becomes a sizable innovation cluster. This is the typical pattern of innovation cluster development and most of the government policies are following this model. This downstream evolution pattern usually requires a long period of time for the policy makers as we can see from the Silicon Valley case since the linear innovation process from R&D to commercialization takes a long period of time.

There is another opposite pattern, where the forming of an innovation cluster starts from the market. As we can see from small S/W areas in the big cities around the world, the clustering of the programmers and S/W companies began with big demand in the city. As the cluster grows it expands its specialization into R&D too. This kind of development pattern usually happens in the fields of bio-industry and business consulting services too. Contrary to down-stream evolution pattern, the up-stream evolution pattern takes a relatively short period of time for the full development. However they tend to be smaller in the area and are closely linked to the conditions of large cities.

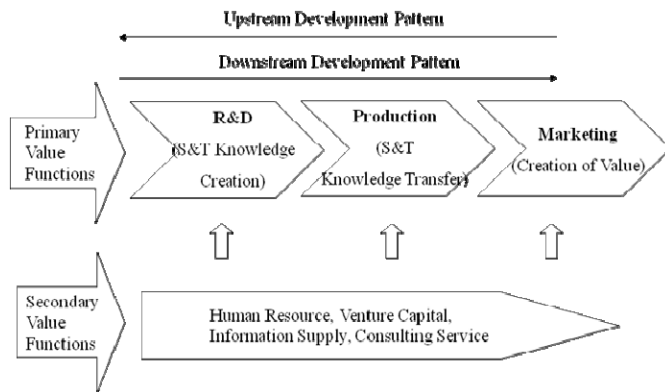


Fig. 1. Two development Patterns of Innovation Cluster
Source: Yim (2002)

This two development pattern of innovation cluster provides important insight for the innovation cluster policy. As in the most cases, the innovation cluster policy start with providing R&D factors such as research centers, researchers and research programs. But the development pattern shows that there has to be also other related factor of production, marketing and secondary value functions. This is often neglected when the government policy was set-up for science and technology parks. It is necessary to provide the secondary value functions in the context of business supporting infrastructure such as availability of venture capital, information, consulting service and so on. In a nutshell, something more beyond Science and Technology are needed to develop the innovation cluster.²

The innovation cluster has its life cycle, which has “S” look. When it starts to grow the growth rate is not high and takes a long time to reach a kind of growing moment. This

fact is important because government has to wait a long time and continue to support the cluster to establish a real sustainable cluster. However, when it reaches certain critical mass point, it grows very rapidly almost by the dynamics within the cluster itself. Finally it reaches some saturation point, from where it can grow further, maintain the status quo or die out.³

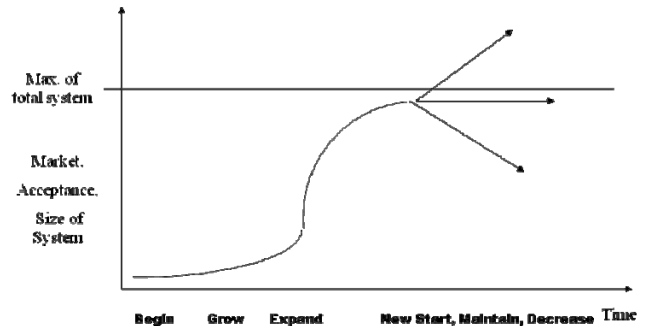


Fig. 2. S-type of Innovation Life Cycle
Source: Yim (2008)

The review of previous studies and many STPs shows that there are many factors or conditions for the successful innovation cluster ([2], [3]). First of all, as we have seen in the two development patterns of innovation cluster, the existing S&T capability itself is the prerequisite and important success factors. Others are excellent incubator, venture capital, human resource, innovative culture, location, management and characteristics. For the market factor, it was important but somehow decreasing because of the globally open market, especially for the technology based products.

For the innovation cluster to succeed, it has to have many success factors. Not only R&D and technology factors, but the policy and management are very important success factors in the development of innovation cluster. Many governments, even with enough resource and good location fail to develop the science and technology parks because they do not provide good policy and management skills.

In this paper, the attention was given to the governance and management factor. It is interesting to see that the governance can be good or bad factor in Asian countries, where the strong central government has most of the power and regional innovation system was relatively less developed compared to that of western countries.

² Ibid.

³ Ibid.

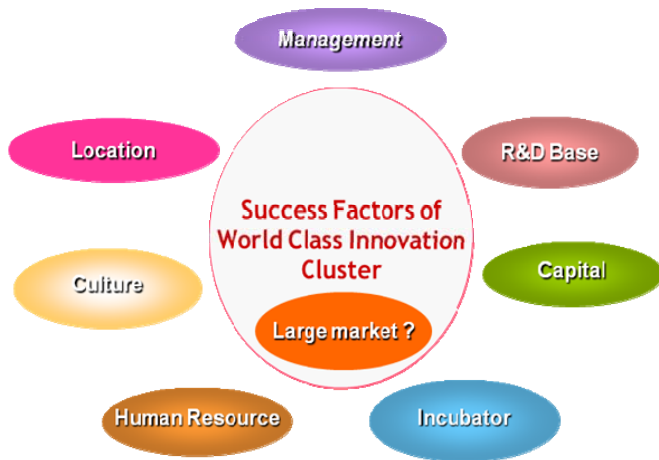


Fig. 3. Key Success Factors of Successful Clusters
Source: (Yim, 2004)

III. EXPERIENCE OF KOREA⁴

A. Innovation Cluster Policy in Korea

In Korea, there are many kinds of innovation cluster policies at both national and regional policies. The “innovation cluster paradigm” was introduced seriously with previous Roh Moo-hyun Government (2003~2008). When OECD was working for the cluster-oriented policy, the concept of “innovation cluster” was introduced by Dr. Deok Soon Yim in 1999 for the first time in the world.⁵ In 2003, Korean government started to emphasize the cluster paradigm at all the science and technology policies including some industrial policy. As a result, many ministries started its own cluster policies. For instance, the former Ministry of Science and Technology made a “special law on the Development and Promotion of Daedeok Special R&D Zone,” to promote innovation cluster. It aimed specifically at changing the

traditional Daedeok Science Town, which was the simple agglomeration of S&T actors, to the world innovation cluster by incorporating the clustering effects.

Other ministries, like Ministry of Commerce, Industry and Energy (MOCIE) has put the components of innovation cluster for the existing Technoparks by introducing some program to connect innovation actors like industry, university and research centers. In addition, it made new programs to create mini-clusters inside the existing industrial complexes. Ministry for Health, Welfare and Family Affairs has been establishing Osong Bio-technopolis since 1997 as to create the front base for the 21st century bio-health industry. According to the master plan, it aims to produce synergy effect from organic interchange among industry, academia, research bodies and government.

The innovation cluster policies can be divided into two categories. One is to change the existing S&T related parks, zones into innovation clusters while the other one is to create totally new innovation cluster. This policy paradigm is based on the assumption that former Science and Technology Parks were built without the consideration of cluster concept. Therefore it is required to complement missing elements in the STPs. For instance, the S&T parks (complexes) would incorporate (or add) the component of production and marketing while the production oriented industrial complexes would include R&D functions more.

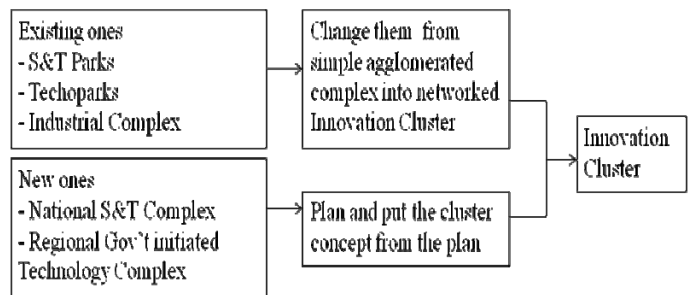


Fig. 4. The direction of innovation clusters policy in Korea

It is interesting to see that the “Presidential Committee on Balanced Regional Development” had coordinated, in fact, the innovation cluster policies of many ministries. It identified the innovation cluster policy as a key tool to develop regional economy and to achieve the balanced development in the nation.⁶

⁴ The part of “Experience of Korea” was a little bit modified from the submitted draft to the KORANET, “Korean scientific cooperation network with the European Research Area” for the program of “An initiative to intensify and strengthen the regional S&T cooperation between Korea and the ERA,” which is written by Deok Soon Yim in 2009.

⁵ Yim, the former research fellow at Science and Technology Policy Institute, has invented the concept of “innovation cluster,” which is slightly different from the OECD terminology “Innovation Cluster” because innovation cluster focuses on R&D, and S&T based cluster whereas innovative cluster refers any cluster as long as it is innovative regardless of the main function - R&D, production or service - of the cluster. He and other colleague researchers has done a series of studies at Daedeok Science Town and contributed to the wide distribution of the ideas of “innovation cluster” in Korea.

⁶ In the current government, “presidential committee on the balanced development” has been changed into “presidential committee on regional development” leaving the concept of balanced development.

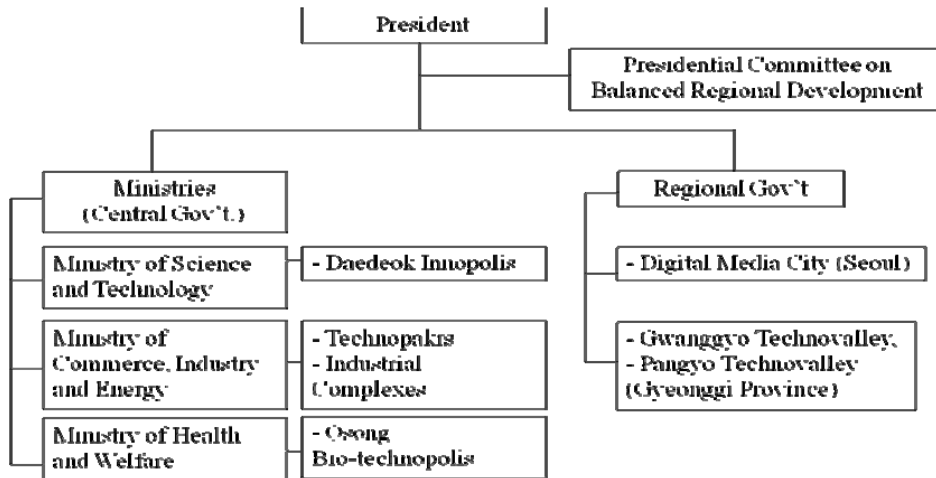


Fig. 5. Innovation clusters and concerned authorities

Even though various innovation cluster policies share same paradigm, it seems that they are different from one ministry to other ministry. For example, Ministry of Education, Science and Technology is focusing more on R&D and S&T development while Ministry of Knowledge Economy does on technological support, transfer, equipment use, commercialization and production. Ministry for Health, Welfare and Family Affairs has been establishing the Osong Bio-technopolis and it will be completed in the near future. The projects of Regional governments are not fully completed but there are many companies and research centers, which are in operation.

B. Daedeok Innopolis

Daedeok Innopolis is the representative example of Korea's innovation cluster policy initiatives. Being

conceptualized in 1973 as a national R&D complex, Daedeok Innopolis has significantly contributed to the development of Korea's science and technology and industry. For instance, the development semiconductor, CDMA application system and WiBro (which has been adopted as an international standard for mobile communications) made Korean IT industry strong in the world market. Korean style of nuclear power plant, Arirang satellite, and Hubo robot are also excellent examples of scientific achievement of Daedeok Innopolis. Daedeok Innopolis, the biggest Science Park in Korea, now houses 977 organizations including 28 big government sponsored research institutes(GRIs), 6 universities and 898 companies in its 70.4Km² area.

TABLE 1. OVERVIEW OF INNOVATION CLUSTER POLICIES IN KOREA

Paradigm	Focus on the synergy coming from the networked innovation actors in the cluster (or same region, or complex)				
Authority	Ministry of Education, Science and Technology	Ministry of Knowledge Economy		Ministry for Health, Welfare and Family Affairs	Regional Gov't.
Innovation Cluster	Daedeok Innopolis	Industrial Complex	Technopark	Osong Bio-technopolis	Digital Media City (Seoul) Gwanggyo Technovalley, Panyo Technovalley (Gyeonggi Province)
Aim of Policy	To make R&D based innovation cluster	To make manufacturing oriented industrial innovation complex	To support technological innovation at the region	To create bio innovation cluster	To create regional innovation cluster
Agency	Daedeok Innopolis Management Office	KICOX (Korea Industrial Complex Corp.)	Each regional Technopark Foundation	MM and Development Task Force office	Agencies of Regional Governments
Policy direction	Changing the simply agglomerate R&D actors to networked actors	Creating mini-clusters with industry, academia, and research centers	Supporting technology transfer, incubation and providing equipments	Creating new innovation clusters for specific purposes	Creating new innovation clusters for specific purposes

The history of Daedeok Innopolis can be summarized as follows. First it was conceptualized as Daedeok Science Town (DST) in 1973. The Korean government developed a plan to create a new science town to accommodate national research and education functions away from the crowded Seoul metropolitan city. So, the basic plan was made to build a research city in the middle of Korea.

Since then DST has undergone four consecutive stages of development: Construction of infrastructure, Creation of Innovation, Formation of Innovation Cluster, and Growing Innovation Cluster. During the construction of infrastructure stage (1973-1992) basic research facilities were built and meanwhile DST took the role of assisting industrial technology development. After the construction started in 1974, the first government sponsored research institute (GRI) moved in to DST in 1978 and the completion ceremony of Daedeok Science Town went in November 1992.

In the stage of Innovation Creation (1993-1997), the innovation results started to come out. During this period the necessary policies were taken like Daedeok Science Town Administration Law and Daedeok Science Town Management Plan. At this period, many government sponsored research institutes (GRIs) started to produce much result both in science and technology. However, the synergy or network among the university, industry and research institute is very low in the degree and almost no spin-off company was there in DST.

In the stage of Innovation Cluster Formation (1998-2003), many companies started to spin-off from the government research institutes. Right after 1997 financial economic crisis in East Asia, the government research institutes went through restructuring, which promoted spin-offs of researchers of GRIs. As a result, there appeared many venture companies and the technology of GRIs were transferred and commercialized in the private market. In addition, with the help of venture bubble in stock market, venture start-ups were increased exponentially in late 1999 ([2], [3]). Daedeok Science Town Administration Law enacted in 1999 and allowed the commercialization activities of R&D and venture start-ups in the DST. This was a big step to the innovation cluster in fact. As a result, the industry, university, research institute network started to form significantly. However, the management for the DST was not there. The role of Daedeok Management Office was very limited to maintaining the DST infrastructure such as road, building, and sport facilities.

In the Growing stage of Innovation Cluster (2004-present), the law of Daedeok Special R&D Zone was enacted. As a result, new name was given as “Daedeok Innopolis” and the area was expanded about three times. More importantly, new Daedeok management Office (HQ) was established with more functions and big organization. Now it has bigger

budget to promote Daedeok Innopolis to become world class innovation cluster and has programs for global marketing, technology commercialization and so on. This means that the management was strengthened for the Daedeok with new promotional programs. It can be said that the role of Daedeok Innopolis Management Office was changed from the regulator to promoter and coordinator. In addition, there were changes in governance. When the law was introduced the concerned ministry was Ministry of Science and Technology but it is now Ministry of Knowledge Economy. With the change of concerned ministry at this government, it is required that Daedeok Innopolis produce more economic result rather than basic Science and Technology.

Since 2005, when the “Daedeok Special R&D Zone Law” was enforced to support Daedeok, it has been raising venture fund, up to about 70 billion won, for new business support. As of 2008, the total number of companies is 898 and the total revenue has reached 9 trillion won. The amount of R&D budget has gone up to 4.7 trillion won. The number of employment may be relatively small in global standards, but taking into account professional human resources concentrated in the area, the regional impacts would not be negligible – 6,800 Ph.D.s out of 21,542 employees.

It is noteworthy to mention the constant efforts of Korean government for the Daedeok Innopolis. The central government has been long-time supporter for such a big project since 1973. Secondly, it has changed its policy as the situation changes. Daedeok was conceptually as the science town at the beginning. However, the industrial production was allowed in late 90s with the emphasis on venture spin-off. And in 2004, the paradigm of innovation cluster was introduced and new law (Daedeok Special R&D Zone Law) was enacted. According to new paradigm, the policy goal of Daedeok is to make “the world class innovation cluster” beyond simple R&D complex. In order to achieve the goal, there have been many efforts.

It seems that the results of innovation cluster paradigm are coming out positively and Daedeok is being developed into well-functioning Innovation Cluster. For instance, there are now many internal/external networks, and small scale clustering phenomenon is appearing among industry, university and research institute. Daejeon Metropolitan City government has organized World Technopolis Association (1998) and the 2010 IASP World Conference was hosted. Considering the growth trend of companies and sales, it seems that Daedeok has entered into the development path of early stage of Innovation Cluster based on its accumulated technological capabilities. However, the time will tell us that whether the policy change was successful or not because the networking or cluster dynamics in Daedeok is not that much active as we can see in other advanced countries.

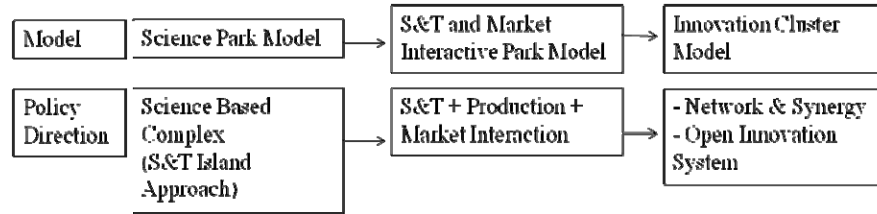


Fig.6. Policy Paradigm Change for Daedeok Innopolis

Daedeok Innopolis gives a unique experience or model to us. It has started when Korea was very less developed. It is national/central government project to support national purpose rather than regional innovation. The major player has not been university or industry but Government Research Institutes. Only recently the relative role of university and industry is increasing. It has started with small market and Science Park was the model instead of business or industry oriented technology complex. But after constant change, it is heading to be the world-class innovation cluster.

C. Technoparks

In Korea, Technopark policy was designed to establish a technology hub center for the regional innovation system. Technopark is expected to be a kind of headquarter, where the technology organizations, buildings, and facilities are aggregated as a regional innovative base and support regional innovation. With this aim in mind, the former Ministry of Commerce, Industry and Energy (now, Ministry of Knowledge Economy) has selected and designated 6 regional Technoparks with the cooperation of regional governments in 1994. As of 2008, 17 Technoparks throughout the nation were designated, which are Songdo, Gyeonggi, Daegu, Gyeongbuk, Chungnam, Gwangju, Busan, Pohang, Gangwon, Chungbuk, Jeonbuk, Jeonnam, Gyeongnam, Ulsan Industry Promotion, Gyeonggi Daejin, Seoul, Daejeon.

The vision of Technopark is to activate the regional economy. Technopark is to be the core organization for the promotion and development of the regional technologies and regional industries. In order to do that, Technopark provides three functions. First, it performs the function of “planning policies, encouraging the business start-ups, supporting the small and medium venture companies, and developing the core technologies for the promotion of the regional strategic industries,” for the technological competitiveness of the regional industries and activation of the regional economies.

Second, it aggregates the industrial infrastructure and the solutions for company support through the collaboration of the linkages of “Industry, University, Research Institute, and other related Organization” under the basis of the active support of the central government and regional municipal groups.

Third, it performs the function as the base of the regional innovation to promote, develop the regional industries innovatively through maximizing the synergic effects of Industry, University, and Research Institute.

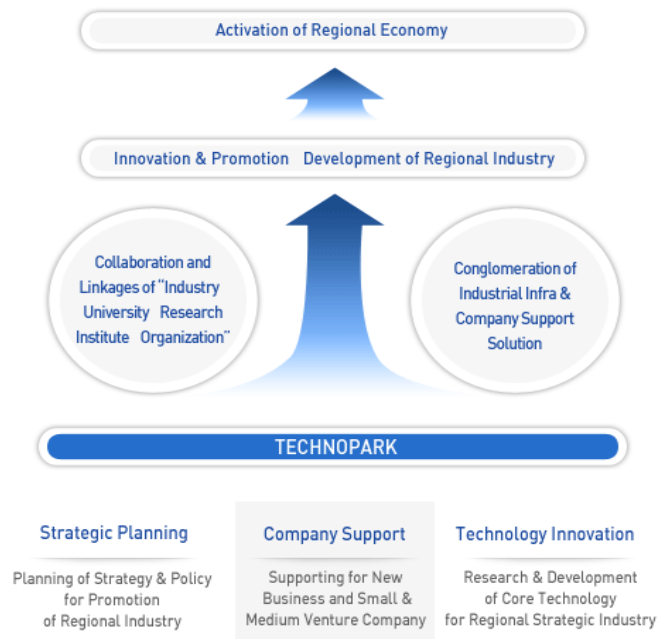


Fig.7. Vision and Objectives of Technopark
Source: <http://www.technopark.or.kr>

For the aspect of governance, the Ministry of Knowledge Economy is supporting each Technopark financially for the building infrastructure and its operation for the initial period. In some cases, regional government also support Technopark with R&D project. In addition, there is usually the university counterpart which has contributed the land or building in the initial period. In 2006, the Korea Technopark association was formed. It works as a representative body of Korea’s Technoparks and promotes the activities of member Technoparks by carrying out the networking, educational, promotional, and joint projects.

For the organizational structure of Technopark, each governor of each city and province carries the director at the board of directors of Technopark. It consists of the company supporting team to support general management issues of companies, the project team to support strategic projects of the region, the industry specialized center for the strategic industries of the region, and the administration team. That is, Technopark is the center organization of each region in order to promote the regional industries and to support the technology based companies.

Technopark has the think-tank function for the regional strategic industries and suggest the policy to both regional and central governments. It also provides various services to companies in the region such as technology equipment rent, technological services, and management consulting.



Fig. 8. Role of Technopark
Source: <http://www.technopark.or.kr>

Since the establishment, Technopark has been supported to grow as the hub of technology support and business in the region. Not only central government, but also the regional government has tried to make regional technology hub around Technopark. According to MKE, the overall regional performances of the Technopark regions have increased as the results of 6 pilot Technoparks' activities in terms of incubation of innovative SMEs, revenue, employment, R&D, technology equipment use, and HRD. It is not yet studied whether the performance increase trend is same for the 17 Technoparks in recent years. Moreover, there seems to be some conflicts between Ministry of Knowledge Economy and regional government for the budget and management direction. In addition, the regional government has limited resource to run the Technopark so that the support of central government has been critical for the operation of Technopark.

IV. CONCLUSION

Science and Technology Park(STP) is one of the effective tools to promote the technology based innovation process in the region. It is also the representative example of the Innovation Cluster, where innovation actors, including the university, industry, research organization and financial institutes, are producing outstanding innovation result at the close distance. That is why many governments are trying to establish the science and technology based innovation cluster.

Science Park, Technology Park, or Innopolis - regardless of the name - are same kind of the innovation cluster in principal. While some of them are successful, many are not successful or - in other terms - just trying to be successful. The research started to find out what are necessary for the success of government supported innovation cluster (STP). For that, relevant concepts of innovation cluster were reviewed and the experiences of Korea were evaluated.

The Daedeok Innopolis had been just a simple agglomeration of Government supported research institutes for a long time and there was virtually no management function other than maintaining basic infrastructure like road and sport/culture facilities. However, as the government has put new efforts for the management and commercialization, it could move to the development stage of active innovation cluster. In addition, new governance of Ministry of Knowledge Economy is pushing the Daedeok Innopolis to more result oriented innovation activities.

Technopark case shows that the central government initiative has provided a new momentum to build regional technology hub center. The support from both central government and regional government were very effective in building regional technology hub. However, there are still some underlying problems because it was top-down policy from central government to regional government. Moreover, regional governments have limited resource not only in the money but also in the people. So there is a delicate conflict situation over the decision making and resources.

Both Daedeok Innopolis and Technopark experience are similar in that right management plan were not given appropriate attention. And they are central government initiated ones and did not receive enough input from regional government side as we can see from the western countries. It is also true that many policy makers and experts have been pointing out that the right governance and right management are needed. In response to such an opinion, Korean government has introduced new legal status to Daedeok Innopolis and it is changing fast since then.

It is known that there are many success factors of innovation cluster such as location, availability of high quality manpower, good living environment, excellent universities, and so on. Since many of the innovation clusters were supported by central/local governments, the governance itself influences the performance of innovation cluster to the large extent. In addition, the support and resource of central government is critical for the successful development of an innovation cluster. In many cases, little thoughts were given to the governance and management of the innovation cluster. In the beginning of policy setting and implementation, government officials and politicians are interested mostly at hardware part of STPs like building, roads and the software parts of innovation cluster are neglected.

The innovation cluster policy in Korea has been changing according to the changes of policy paradigm and government. It may be a little dangerous to generalize the experience of Korea. However, it is true that if the right governance and

management were not incorporated, it would result in poor performance of STPs. With this conclusion, it is suggested that policy makers to consider more of the governance and management function at beginning of innovation cluster (STP) policy.

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