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Evolution of Innovation Clusters from Park-Type to Network-Type: Focusing on Innovation Cluster Analysis and Strategic Direction Setting

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Abstract. In this study, Innopolis was analyzed as an innovation cluster and a strategic direction for development was established. The innovation cluster develops from a park type to a network type, and the purpose of the study is to analyze the entire Innopolis and set a strategic direction based on it. Innopolis was expanded to Gwangju, Jeonbuk, Daegu, and Busan in addition to Daedeok, and this evolution was reviewed through cluster analysis. In this study, all these innovation clusters were examined in an integrated way beyond the analysis of individual innovation clusters. Through cluster analysis, the increase in the number of companies in the Innopolis and the increase in company sales were examined. Reflecting the 3T perspective, which is a requirement for becoming a creative city, Technology investment (T1), Talent(T2), and Tolerant culture (T3) were analyzed. In addition, it was considered that many companies were listed on the KOSDAQ through the achievements of these innovation clusters. In addition to these superficially observed results, a large finding is that there is a big difference in performance between the Daedeok Innopolis and other R&D Innopolis. The following strategic directions were set by comprehensively considering this cluster analysis. First, a wide-area technology commercialization program should be operated to enable technology commercialization nationwide. Second, a program that can share technology, manpower, and resources among innovation clusters must be operated. The third is to build a technology commercialization ecosystem centered on Innopolis. Innovation clusters are constantly evolving. In order for Innopolis to develop as an innovation cluster, periodic cluster analysis and strategic direction setting are necessary as discussed in this paper.

Keywords: innovation cluster, cluster analysis, Innopolis, evolution, strategic direction

1. Introduction

In today's rapidly changing business environment, the importance of innovation clusters is growing. In terms of national science and technology policy, innovation clusters are also becoming a major policy tool (OECD. (1999); OECD. (2001)). There is an innovation cluster at the center of regional innovation, and companies can develop while enhancing their competitiveness in the innovation cluster. In addition, it is an important science and technology policy at the national level because the country can secure competitiveness through the creation of such innovation clusters (Porter 1998; Cooke et al., 1997).

From this point of view, it is very important to consider and analyze how clusters grow and develop. An innovation cluster develops through the stages of incubation, growth, maturity, and readjustment. In general, innovation clusters are regionally limited and developed through collaboration between industry, academia, and research institutes (Porter 1998; Cooke et al., 1997).

Daedeok R&D Special Zone, called ‘Daedeok Innopolis’ develops not only regionally, but also with a different aspect of national expansion, and this study examines how this development is achieved. The R&D Special Zone started from the Daedeok Research Complex in 1978 and developed into the Daedeok Research and Development Zone, called ‘Daedeok Innopolis’. In other words, beyond Daedeok R&D Special Zone, the special zone system, called ‘Innopolis system’ spread to Jeonbuk R&D Special Zone, Gwangju R&D Special Zone, Busan R&D Special Zone, and Daegu Special R&D Zone, and innovation clusters were established for each region (Ministry of Science and Technology. (2006); Ministry of Knowledge Economy. (2011); Daedeok Innopolis. (n.d.)).

In this paper, the R&D special zone is referred to as ‘Innopolis’, the official name from here on. The Daedeok R&D Special Zone is called Daedeok Innopolis, and the Jeonbuk, Gwangju, Busan, and Daegu Special Zones are called Jeonbuk, Gwangju, Busan, and Daegu Innopolis.

Aside from Innopolis in Daedeok, Gwangju, Jeonbuk, Daegu, and Busan, very small Innopolis began to be created across the country from 2020, reflecting regional characteristics. In general, innovation clusters appear in the form of science parks in which industry-university-research institute innovation agents are concentrated in the region. Afterwards, a belt type that connects with other innovation clusters is sought in order to make up for the shortcomings of the park type and to mobilize resources from other regions.

In Gyeonggi-do, since Pangyo Techno Valley is IT-centered and Gwanggyo Techno-valley is BT-centered, a belt-type formation for linkage between them has been studied as a desirable model (Lee 2012; Pangyo Techno Valley; Gwanggyo Techno Valley). The Innopolis started from Daedeok and was evaluated as the largest innovation cluster in Korea, and later spread to Daegu, Busan, Gwangju, and

Jeonbuk, and was evaluated as a belt-type connection between them. Since then, it can be said that it spread to a nationwide network by spreading small Innopolis across the country (Ministry of Science and Technology. (2006); Ministry of Knowledge Economy. (2011); Daedeok Innopolis. (n.d.).). As innovation clusters expand in this way, it can be said that systematic analysis of innovation cluster performance and research on setting strategic directions based on this are very necessary.

Therefore, this study compared and analyzed Daedeok Innopolis as well as Jeonbuk, Gwangju, Busan, and Daegu Innopolis through cluster analysis. Through this cluster analysis, the future image of the Innopolis innovation cluster, a new Korean model, is considered and a strategic direction for development is set. Innovation clusters do not develop through industry-academia-research collaboration alone, and it is necessary to analyze the performance of innovation clusters according to their evolution and set a strategic direction based on this. In this sense, it can be said that this study, which analyzes the performance of innovation clusters according to evolution, is very necessary.

The progress structure of this study is as follows: In this study, after the introduction, Chapter 2 examines innovation clusters and evolution of innovation clusters as a theoretical background. In Chapter 3, cluster analysis is considered as a research method. Chapter 4 analyzes the corporate performance of Innopolis through cluster analysis, and additionally conducts performance analysis from the 3T perspective. Chapter 5 establishes the strategic direction for the development of Innopolis based on this analysis. Chapter 6 is the conclusion and implications.

2. Theoretical Background

2.1. Innovation cluster

An innovation cluster is an integration of various innovation entities such as universities, companies, and research institutes in a specific region (OECD. (1999); OECD. (2001)). Innovation clusters can be said to be a space for value creation where innovative agents create synergies by interacting in the region beyond simple integration (Porter 1998; Cooke et al., 1997). In many countries, innovation clusters are strategically nurtured because innovation clusters are very useful and generate significant results in terms of national science and technology policies. Countries that pursue growth according to the catch-up strategy in the past, such as Korea, recognize that innovation clusters are a very important policy tool in terms of national policy. Hong Kong Science Park (HKSP) and Singapore's Bio Park are representative examples (Hong Kong Science Park (HKSP); Singapore Science Park). In addition to countries pursuing growth as a national policy, Silicon Valley in the United States has spontaneously grown into a cluster that leads cutting-edge

technology (Isaacs 2006). In Silicon Valley, there are high-tech companies such as Apple, Tesla, and Google, and startups continue to take place.

In Korea, innovation clusters include Pangyo Techno Valley, Gwanggyo Techno Valley, and Ansan Science Valley in Gyeonggi-do, as well as Daedeok Innopolis, which started from the largest research complex in the country. Pangyo Techno Valley has grown into an innovation cluster leading cutting-edge IT technology in 10 years (Pangyo Techno Valley). Pangyo Techno Valley has numerous game companies and internet companies. It can be said that it is an innovative cluster that developed in a short period of time by taking advantage of its proximity to Seoul (Pangyo Techno Valley). Gwanggyo Techno Valley has grown into an innovative cluster centered on bio-convergence technology and startups centered on the Gyeonggi Bio Center and Nano Center (Lee 2012; Gwanggyo Techno Valley). Ansan Science Valley has grown into a cluster that greatly contributes to corporate value creation in connection with the nearby Banwol-Sihwa Complex, where Hanyang University Erica Campus, Gyeonggi Techno Park, and various research institutes are concentrated (Ansan Science Valley). As such, each country recognizes the importance of innovation clusters and strives to create them, providing support in various hardware and software aspects. Of course, the subject of value creation is a company, but the central and local governments are making efforts to provide a physical and institutional space for companies to accumulate.

2.2. Innovation and entrepreneurship in innovation clusters

Innovation and entrepreneurship are what give innovation clusters their dynamism (OECD. (1999); OECD. (2001)). In the innovation cluster, industry, academia, and research institutes are collaborating. In addition to academic research, venture investment (VC) and various non-profit organizations exist to create synergy (Porter 1998; Cooke et al., 1997). The subject of value creation in these innovation clusters is the enterprise, and it can be said that continuously creating such enterprises is a very important task in the innovation cluster. Silicon Valley in the United States is not simply an industrial cluster where industry, academia, and research subjects are connected, but also a place where numerous institutions that enable start-ups are gathered (Isaacs 2006). In the innovation cluster, many start-ups take place, so it can be said that these start-ups should grow while connecting with various industry-academia-research subjects. In order for such a natural start-up to be possible, there must be a lot of research and development activities and a process of supporting technology commercialization. R&D activities of universities and research institutes should be naturally linked to entrepreneurship (Porter 1998; Cooke et al., 1997). Many innovation activities can be linked to R&D and commercialization, and interactions that continuously form links between markets, products, and technologies in the local space may appear (Porter 1998; Cooke et al., 1997). An innovation cluster can be said to be a space where innovation and entrepreneurship

take place. It can be said that innovation culture, human resources, and residential space are important to create such a space. Lee Won-il and Choi Jong-in (2015) present a new model for domestic industry-academia cooperation utilizing the capabilities of innovation cluster universities. The "Innovation Voucher" program operates programs such as technology development support, consulting, technology certification support, and marketing support. Through these innovation vouchers, venture companies can grow step by step.

Lee Won-il and Choi Jong-in (2015) conducted a study on science and technology policy and industry-academia cooperation in Daejeon, Korea. Daejeon's science and technology ecosystem was analyzed. Daejeon's science and technology policies include fostering innovative clusters and fostering strategic industries linked to the region.

2.3. Evolution of innovation clusters

Innovation clusters develop as they grow. The S-curve of technological innovation generally appears in the stages of infancy, growth, maturity, and decline, and is replaced by other new technologies (Rodenburg 1982). Similar to the S-curve of innovation, innovation clusters also evolve. Innovation clusters appear in the pre-cluster formation stage, incubation stage, growth stage, and readjustment stage (Rosenburg 1982; Sadik 2001; SRI International (1999)). In the pre-cluster formation stage, the innovators of the innovation cluster prepare for various cooperation for networking. Afterwards, industry-academia-research institute innovation agents begin to connect and synergy creation begins. Afterwards, in the growth period, industry-university-research institutes are linked to create new innovations and start-ups are active (Sadik 2001; SRI International (1999)). This can be said to be the stage in which the innovation achievements within the innovation cluster spread to neighboring areas. In the readjustment period, it can be said that the main technology of the innovation cluster changes according to changes in the technological external environment (Sadik 2001; SRI International (1999)).

3. Research Method

3.1. Research method

In this study, innovation cluster analysis was conducted as a research method. In order to understand the development of innovation clusters, the following contents were analyzed. First, the number of innovative cluster companies was identified. This means the concentration rate of companies that are the main agents of value creation in innovation clusters. Second, the performance was identified based on the company's sales within the innovation cluster. Third, technology, talent, and tolerant culture were identified based on the 3T mentioned by Richard Florida in Creative City (Florida 2005; Florida 2019). Fourth, based on these results, the number of

companies listed on the KOSDAQ was considered. Statistical data was obtained based on data disclosed on the Innopolis website. This information is disclosed to the public, and a graph is drawn based on it. Based on these data, innovation cluster analysis was used to visualize graphs

3.2. Innovation cluster analysis

Innovation cluster analysis can be used to identify performance or various collaborations within a cluster. Through this analysis, it can help establish a cluster policy (Lee 2012; Lee 2008; Scarpa and Caserta 2020; Lu 2021; Olasupo and Bheki 2021). Within the cluster, there are various industry-academia-research cooperation entities, and they create various outcomes. In addition, there are certain patterns in cooperation [7][16]. In this study, through the overall cluster analysis of Innopolis, the researchers examined how much the performance of all Innopolis increases after the development of Daedeok Innopolis and what characteristics they have. The statistical data of this study are based on the statistical data disclosed on the Innopolis website. In some cases, Innovation cluster analysis is conducted to investigate industry-university cooperation through questionnaires to companies within the innovation cluster. Through this, it is to ask and organize the current status of industry-university cooperation, difficulties, and policy support measures. Innovation cluster analysis in this study is not focused on industry-university cooperation, but on the performance of companies. It can also be said that it is not just staying in one region, but reviewing the performance of Innopolis in Daedeok, Gwangju, Jeonbuk, Daegu, and Busan, and setting a strategic direction through this.

3.3. Indicators used in innovation cluster analysis

The researchers identified the number of companies as an increase in the number of companies in Innopolis in Daedeok, Gwangju, Jeonbuk, Busan, and Daegu. Corporate sales were identified as increases in corporate sales in Innopolis in Daedeok, Gwangju, Jeonbuk, Busan, and Daegu. In terms of sales, the unit is KRW 1 million.

The technology considered from the 3T perspective was identified as the amount of R&D investment.

Talent was identified by the number of R&D personnel. R&D manpower is the sum of research manpower and technical manpower. Tolerant culture was measured by the number of non-research field organizations located in Innopolis. Although the tolerant culture can be identified through questionnaires, in this study, the increase in the number of non-research field organizations in the innovation cluster was identified as an indicator of the tolerant culture.

4. Identification of the evolution of innovation clusters through Innovation cluster analysis

4.1. The evolution of Daedeok Innopolis into an Innopolis system

Daedeok Innopolis is the best technological innovation hub located in Daejeon that supports start-ups. Starting as a national research institute in 1978, it has developed into a complex innovation ecosystem that connects government-funded research institutes, venture companies, mid-sized companies, and universities for the purpose of industry-academia cooperation and synergy creation (Ministry of Science and Technology 2006; Ministry of Knowledge Economy 2011; Daedeok Innopolis (n.d)). It started with the establishment of a national research institute in 1978 and developed into Daedeok Innopolis for commercialization of research results. The success of Daedeok Innopolis led to the expansion of the system to other regions in Korea, including Jeonbuk Innopolis, Gwangju Innopolis, Daegu Innopolis, and Busan Innopolis (Ministry of Knowledge Economy 2011; Daedeok Innopolis (n.d.)).

4.2. Evolution of innovation clusters and increase in number of companies

Fig. 1 shows a steady increase in the number of companies along with the growth of Jeonbuk, Daegu, Gwangju, and Busan Innopolis in addition to the Daedeok Innopolis. The blue graph represents the total, and the orange represents the Daedeok Innopolis. 2,243 companies moved into the Daedeok Innopolis, and since 2010, the number of companies in Daegu, Gwangju, and Busan Innopolis has been steadily increasing.

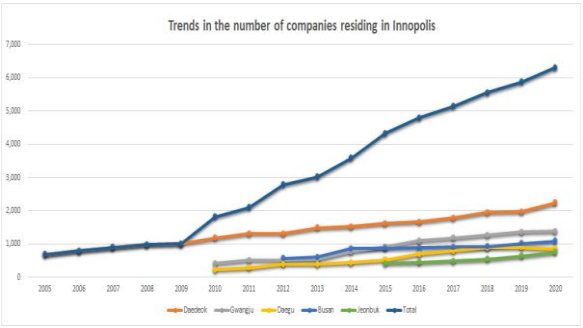

Fig. 1: Steady increase in the concentration of companies in R&D special zones, ‘Innopolis’

4.3. Evolution of innovation clusters and increase in corporate sales

A steady increase in corporate sales can be observed in Innopolis as shown in Fig. 2. In an innovation cluster, companies can grow while collaborating with other industry-academia-research institutes. In addition to the concentration of companies, corporate sales are increasing through support for technology commercialization and technology transfer. The blue line is the total company sales, and the orange line is the company in the Daedeok Innopolis.

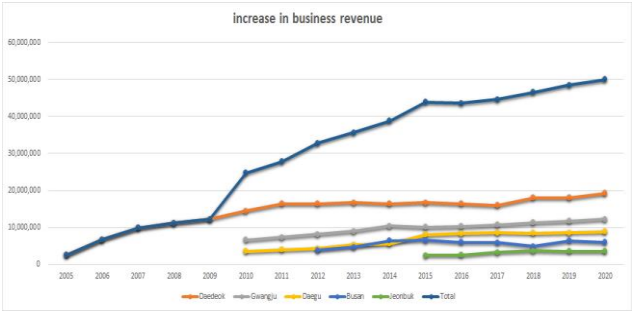

Fig. 2: Increase in corporate sales in R&D special zones, 'Innopolis'

4.4. Evolution of innovation clusters and analysis from the 3T perspective: Technology, talent, and tolerant culture

In addition to the increase in the number of companies in Innopolis and the increase in corporate sales, the development of the city is viewed from the perspective of Richard Florida's "3T" model for a creative city, which comprises of three essential components: technology, talent, and tolerant culture. Technology refers to the city's technology and innovation base, talent refers to the presence of a highly skilled workforce, and tolerant culture refers to acceptance of diversity (Florida 2005; Florida 2019).

Technology

R&D investment in Innopolis has steadily increased. Daejeon, where the Innopolis is located, is a science and technology city, and most of the government-funded research institutes are also located here. In Figure 3, the blue graph is the R&D investment within the entire Innopolis, and the orange graph is the investment in the Daedeok Innopolis. Since Daedeok Innopolis receives more national R&D investment than other regions, it can be said that it is necessary not only to promote technology commercialization of R&D achievements in the Daedeok region only in the vicinity, but also to establish a nationwide technology commercialization platform that spreads nationwide.

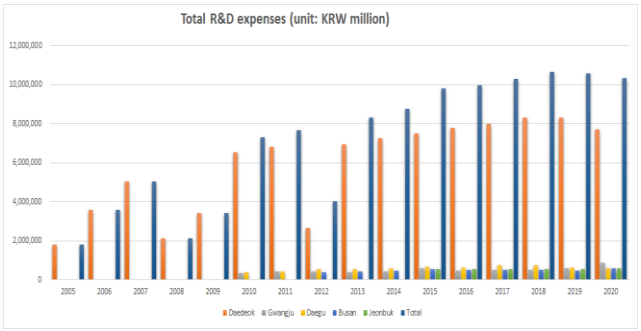

Fig. 3: R&D Investment in Innopolis: Technology (T1)

The cases of technology transfer of the results created after R&D at Innopolis are also continuously increasing as shown in Figure 4. Patents are created after R&D, and there are increasing cases in which companies transfer technology through normal or exclusive use of these patents. This led to the birth of new venture companies and the growth of existing high-tech companies (Lee 2008). Innopolis' technology transfer activities not only helped companies bring products to market faster, but also created new business opportunities and jobs.

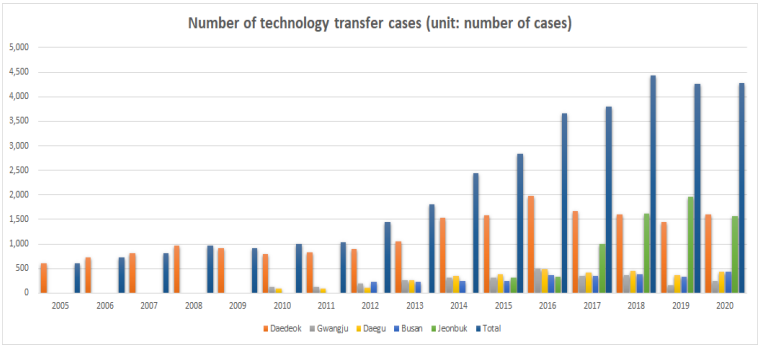

Fig. 4 Number of technology transfer cases (T1)

Talent

In terms of R&D manpower, Daedeok Innopolis has 38,995 people, which means more R&D manpower than other regions. More R&D people generate more ideas, solve more technical problems, and ultimately create more innovations in different industries and fields, and eventually enable more startups (Lee 2008). The blue line in Figure 5 represents the entire R&D manpower, and the orange line represents the manpower of the Daedeok Innopolis. The more technology investment is made in the innovation cluster, the more R&D manpower will be gathered. Not only buildings, transportation, and apartments, but also shopping malls and communication spaces are needed.

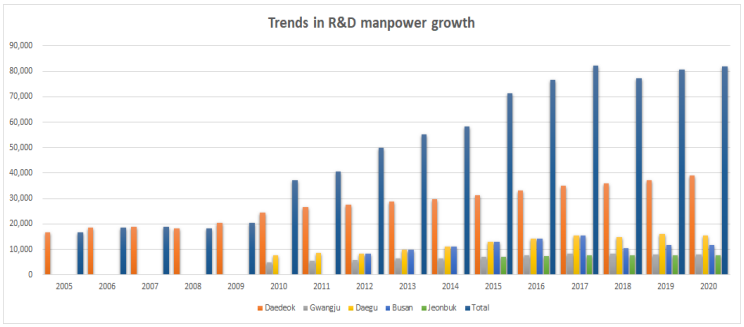

Fig. 5: Research and development manpower in the Innopolis: Talent (T2)

Not only R&D personnel but also production and management personnel have been steadily increasing as shown in Fig. 6. Not only R&D personnel, but also

manpower capable of operating research facility equipment will increase accordingly.

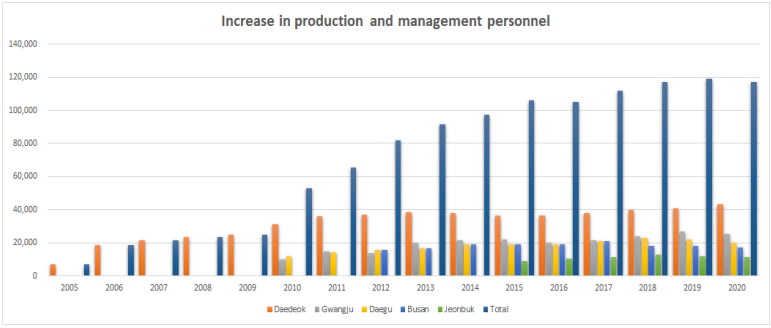

Fig. 6: Production and management personnel in the Innopolis: Talent (T2)

Tolerant culture

Several things can be as indicators of a tolerant culture, but it can be recognized based on the the number of organizations not related to research. If there are only research-related facilities in the R&D complex and no other support facilities, there will be problems in new cooperation. Therefore, the increase in organizations not related to research as well as direct research creates an environment that facilitates research by enabling collaboration. In addition, various institutions such as cultural and social facilities can attract various people and ideas to the innovation cluster, creating a more open and cooperative environment. The existence of non-research organizations in innovation clusters provides opportunities for networking where researchers can exchange ideas and technical information with experts in other fields and have new discussions. Through this diversity and cooperation, new search capabilities can be established at the local level. Non-research organizations in Innopolis steadily increased as shown in Fig. 7.

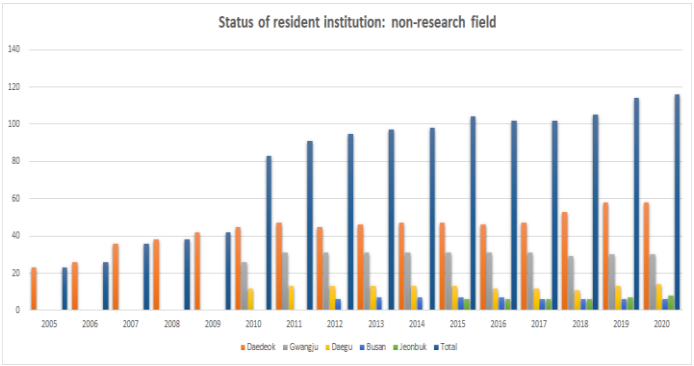

Fig. 7: A non-research field organization as an indicator of a tolerant culture (T3)

4.5. Increase in high-tech companies and KOSDAQ listed companies

So far, the number of companies in Innopolis has increased steadily and their sales have grown. In addition, as considered from the 3T point of view, it can be seen that

the foundation for the formation of technology, human resources, and tolerance culture was created in Innopolis. Because of these efforts, companies are creating many results.

First, Innopolis has steadily increased the number of high-tech companies designated as shown in Figure 8. There are many government-funded research institutes in Daedeok. The number of companies commercializing technology by transferring many of the technologies developed here has increased. Accordingly, the number of high-tech designated enterprises has steadily increased. Some companies are founded by spinning off from research institutes through technology transfer, while others are designated as high-tech companies by utilizing advanced technologies.

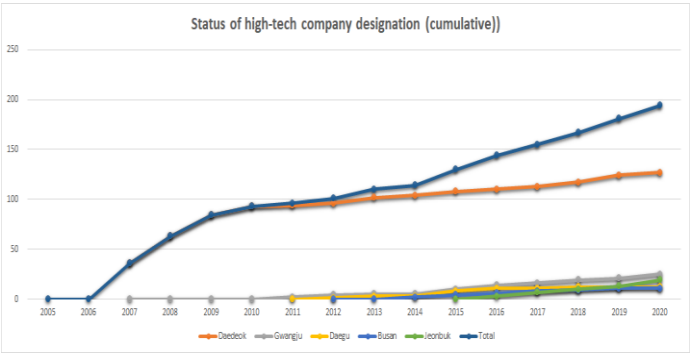

Fig. 8: Status of high-tech company designation

Second, in Innopolis, many companies were listed on the KOSDAQ. So far, 96 companies in the Innopolis have been listed on the KOSDAQ as shown in Figure 9. Of these, 51 companies are located in the Daedeok Innopolis. In Figure 9, the blue graph is the number of companies listed on the KOSDAQ in all Innopolis, and the orange graph is the number of companies listed on the KOSDAQ in the Daedeok Innopolis. Companies founded in Daedeok and listed on the KOSDAQ include Golfzon, Truwin, and Sugentech. These companies have been developing in close association with Innopolis. It is necessary to support these outstanding successful companies so that they can continue to grow. Golfzon is a company specializing in golf simulators. It was founded at KAIST and has grown rapidly in a short period of time based on technology related to golf simulators (Golfzon Homepage (n.d.)). Truwin is an automotive sensor company that makes various sensors needed for future vehicles. Based on sensor technology, it is advancing into various new business areas in the field of future automotive sensors (Truwin Homepage (n.d.)). Sugentech started as a research institute-type company designated by Innopolis. Based on biodiagnostic kits, it is securing and growing technological capabilities in medical diagnostic devices (Sugentech Homepage (n.d.)). These companies have grown through direct and indirect close relationships with Daedeok Innopolis and promoted various industry-academia cooperation.

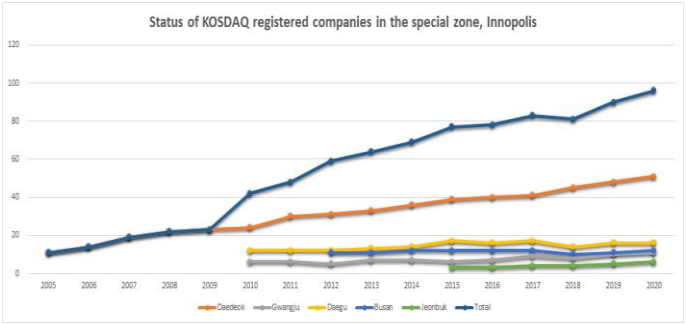

Fig. 9: Status of KOSDAQ registered companies in all R&D special zones, Innopolis

5. Establishment of Strategic Direction for Fostering Innopolis as Innovative Clusters

In order for Innopolis to develop a desirable direction as an innovation cluster, it is important to set a desirable future image. Innopolis in Daedeok, Jeonbuk, Gwangju, Daegu, and Busan should not only develop individually into a park type, but also evolve into a network type that develops in connection with each other. Each Innopolis should develop not only by establishing a regional innovation system as an innovation cluster in the region, but also by creating synergies with each other. It can be said that the future of Innopolis is to develop from a park type to a network type. There may be several strategies that need to be pursued to achieve this future vision.

Based on the results of cluster analysis, the overall Innopolis has increased performance, but only the Daedeok Innopolis has produced many achievements. It is necessary to not only macroscopically consider the Innopolis as a whole, but also to microscopically see individual Innopolis such as Daedeok, Jeonbuk, Gwangju, Daegu, Busan. In addition, it is necessary to consider the connectivity between individual Innopolis. Since 2012, Innopolis have not stayed in Daedeok, but have begun to spread throughout the country. As a result, the performance of other Innopolis other than the Daedeok Innopolis may be relatively insufficient. It is important to prepare a support system so that not only Daedeok but also Jeonbuk, Gwangju, Daegu and Busan can develop their achievements. Considering these aspects comprehensively, the development strategy of Innopolis is drawn in three ways.

First, a wide-area technology commercialization program should be operated to enable technology commercialization nationwide. Most of the government-funded research institutes are concentrated in the Daedeok Innopolis. In addition, there are many government-funded research institutes in Jeonbuk, Gwangju, Daegu, and Busan. It is to build a platform to enable technology commercialization nationwide, rather than technology transfer or technology commercialization of the research results of these government-funded research institutes only with nearby companies.

It is desirable to derive a list of core technologies for each Innopolis every year and always operate a matching program that can organically connect with necessary companies. It is necessary to build a system that can understand and manage the demand and supply aspects of technology so that companies in other regions can utilize Daedeok's technology. Since the government-funded research institute located in Daedeok produces good technological results, it could mean that the commercialization of these technologies is very important. In addition, excellent technological achievements are now being created at research centers in Jeonbuk, Gwangju, Daegu, and Busan. It can be said that it is necessary to establish a wide-area technology commercialization program that can commercialize these technologies in an integrated manner.

Second, a program that can share technology, manpower, and resources among innovation clusters must be operated. Strategic technologies and industries to be nurtured are different among innovation clusters. Wide-area cooperation is needed to foster such clusters. It is important to create a system that can link and cooperate with technology, manpower, and resources in a wide area, rather than enjoying the effect of regional integration. The first example is that to make an electric vehicle, various core technologies such as batteries, motors, electronic parts, and displays are required, and it is difficult to develop all of them in one region. In order to foster industries such as electric vehicles, the various technologies, manpower, and resources of the special zone must be converged. For the second example, in the case of the smart grid, smart power management, smart home appliances, smart renewable energy, and smart electric vehicles are core technologies. In order to foster the smart grid industry, it is necessary to operate a program that can share technology, manpower, and resources among innovation clusters for such technology development.

The third is to build a technology commercialization ecosystem centered on Innopolis. In order to build a technology commercialization ecosystem, new technologies must be continuously produced. In the Innopolis, many government research projects are carried out and many technologies are continuously created. It is important not only to create these technologies, but also to enable companies to utilize them through technology transfer. In addition, it is important to promote actively new entrepreneurship activities through technology commercialization. To make these things possible, patent-related support organizations, technology commercialization consulting companies, and marketing companies are needed centering on Innopolis. Various support organizations and companies must coexist in order for technology commercialization to be successful. If a company wants to achieve high-speed growth in a short period, it may be difficult to achieve technology commercialization with only their efforts as a company. When there is a difficulty, various support organizations may need support. A technology commercialization ecosystem must be established in which not only high-tech

venture companies but also consulting institutions, technology commercialization institutions, patent companies, and marketing companies coexist in the region. In order for the Daedeok, Jeonbuk, Gwangju, Busan, and Daegu Innopolis to grow, it is necessary to create a customized technology commercialization ecosystem for each region.

6. Conclusions

Daedeok Innopolis is the largest innovation cluster in Korea. There are most government-funded research institutes, and there are many venture companies. Currently, the success of Daedeok Innopolis has spread nationwide and expanded to Gwangju, Jeonbuk, Daegu, and Busan (Daedeok Innopolis (n.d.)). In addition, a smaller regional innovation type Innopolis was also created. The success of these innovation clusters is becoming a benchmark for many developing countries. At this point, it is very meaningful to look at Innopolis as an innovation cluster in Korea.

In this paper, evolution of innovation clusters from park-type to network-type was considered. Through cluster analysis, the increase in the number of companies in the Innopolis, the increase in company sales, and the technology investment, human resources, and culture of tolerance were analyzed from the 3T perspective. In addition, it was considered that many companies were listed on the KOSDAQ through the achievements of these innovation clusters. Besides these, superficially observed results, a large finding is that there is a big difference in performance between the Daedeok Innopolis and other R&D Innopolis.

After examining each Innopolis macroscopically and microscopically, the researchers considered the future image of Innopolis. The future of Innopolis can be said to be a belt-type innovation cluster that organically connects Jeonbuk, Gwangju, Daegu, and Busan with Daedeok at the center, beyond the region-based innovation cluster that only contributes to regional innovation.

The following strategic direction was set by comprehensively considering this cluster analysis. First, a wide-area technology commercialization program should be operated to enable technology commercialization nationwide. Second, a program that can share technology, manpower, and resources among innovation clusters must be operated. The third is to build a technology commercialization ecosystem centered on R&D special zones, Innopolis.

In the future, additional research is expected to be conducted through interviews or in-depth analysis of the current situation in setting the strategic direction for the development of innovation clusters. Important things in innovation cluster research and consultation may include setting the future vision of innovation clusters, setting up regional strategic industries, cluster analysis, and setting roadmaps for the future. In this paper, the innovation cluster was analyzed. It can be said that it is important

to understand the current situation and set a strategic direction through periodic analysis rather than one-time analysis.

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