Research on the Reference of South Korea's Science and Technology Industry Innovation Cluster Development to Macao

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Abstract. As an advanced form of Innovation Cluster after the Fourth Industrial Revolution, Scientific and Technological Industrial Innovation Cluster has become an important support to promote the development of national innovation in the future, and the world's advanced countries have optimized the development of Traditional Innovation Cluster according to it. This research introduces the development needs of Macao's Traditional Innovation Clusters through its innovation capability and innovation index, compares the advantages and disadvantages of Innovation Clusters and Industrial Clusters, and discusses the future development mode of Macao's technological innovation by learning experience from the development of South Korea's Science and Technological Industrial Clusters. According to South Korea's experience and the advantages and characteristics of Macao's regions, the construction should be reformed based on the advantages of Industrial Clusters and regional development so as to reduce costs and control the scale of investment. At the same time, it's also vital to actively develop and utilize Hengqin New District, attract top scientific research institutions and talents from the world, in which way Macao's Science and Technology Industry Innovation Cluster could be built.

1. Introduction

The Science and Technological Industrial Clusters is based on Innovation Clusters and Industrial Clusters, under the effect of global industrial economy and technological transformation development, and it is often in accordance with the regular pattern of Development of Science and Technology Industry-Development of Science and Technology Industry Cluster-Development of Science and Technology Industry Innovation Cluster.

As an important science and technology power in the Asia-Pacific region, South Korea has many similarities with Macau, including the development process of Innovation Cluster and the current needs in science and technology [1]. Besides, according to the global innovation index, South Korea ranks first in the world in the six-year innovation index and is recognized as an innovative country in the world.

The research in the field of Innovation Clusters in China is relatively late, but it develops rapidly. After establishing the goal of building an innovative country, Innovation Clusters, as an important embodiment of an innovative country, have become the focus of China's domestic scholars. In addition, Macao is currently facing the important challenges of realizing economic transformation and making its economic development more diversified, and it has an urgent need to promote the development of science and technology innovation industries [2]. It is Macao's development goal to promote diversified economic development, launch scientific and technological innovation cooperation with the mainland,

and promote the overall and coordinated development of economy, scientific and technological innovation and other aspects in Guangdong-Hong Kong-Macao Greater Bay Area (GBA).

2. The Formation and Development of Science and Technology Industry Innovation Clusters

2.1. Definition of the Concept

In 1990, American writer Porter put forward the theory of Industrial Clusters in his book *National Competitive Advantage*. This theory helps to improve the competitiveness of enterprises and the country and starts the embryonic stage of Industrial Cluster construction. However, with the diversified development of the society, the development mode of industrial agglomeration is gradually lagging behind, and the concept of Innovation Cluster arises at the historic moment [3].

With the focus of the Fourth Industrial Revolution on frontier fields such as electronic information and artificial intelligence, the development of Innovation Clusters has gradually focused on science and technology industries, forming a Science and Technology Industry Innovation Cluster, a technological and economic network characterized by core technology aggregation and a large amount of knowledge spill overs, which is jointly constructed by five major elements of industry, innovation, capital, talents and policies in a specific industrial field [4]. Science and Technology Industry Innovation Cluster is an advanced form of the integration of Industrial Cluster and Innovation Cluster.

2.2. The Differences Between Science and Technology Industry Innovation Clusters, Industrial Clusters and Innovation Clusters

Innovation Cluster of Science and Technology Industry is a new form of development pattern formed under the rapid development of economy and science and technology in recent years [5-6]. As a high-end collective form of Industry Cluster and Innovation Cluster, it has obvious advantages over the above two traditional forms [7].

2.2.1. The Advanced Development Mode and the Low Dependence on Resources.

The development the model of Science and Technology Industry Innovation Cluster belongs to innovation-driven development, with innovation capability as the first driving factor, avoiding the dependence of traditional industry resources and the resource-driven development model. Compared with Innovation Cluster, Innovation Cluster of Science and Technology Industry first emphasizes the functional relationship between science and technology and industry.

2.2.2. Strong Adaptability and Simple Requirements of the Development Environment.

The Scientific and Technological Industrial Innovation Cluster has relatively low dependence on the regional development environment. Its development mainly relies on the innovative ecological environment composed of regional innovation resources and innovation policies [8]. Compared with the factors that Industrial Cluster development must have, such as convenient transportation, low water and electricity costs, abundant natural resources, and low labor costs, its requirements are simpler [9-10]. Compared with the Innovation Cluster, which depends on innovation policies and the orientation of industrial demand, its activity and adaptability are stronger [11-12].

3. The Development Needs of Science and Technology Industry Innovation Clusters

3.1. The Development Needs of Science and Technology Industry Innovation Clusters in China

In 2006, China established the strategy of Building an Innovative Country and completed 70 Innovative Industrial Clusters in ten years, which has greatly promoted the country's innovative power [13-14].

Innovation capability mainly refers to 7 aspects, including national R&D Intensity (20% weight, accounting for the proportion of GPD), Productivity (20% weight, per capita GDP of 15-year-old population), High-tech Density (20%), Scientific Research Personnel Density (20%), Manufacturing

Capability (10%), Educational Efficiency (5%) and Patent Activity (5%), which can reflect the overall development of national industries.

The Innovation Index is based on 80 indicators. Innovation Capability and Innovation Index are interdependent. Through the statistics of China's Innovation Capability and Innovation Index (table 1) in the past 6 years, it's obvious that under the effect of policies and cluster construction, China's national Innovation Capability and Innovation Index have been improved rapidly in the world, and its improvement range is relatively stable. However, in terms of Innovation Capability, whose progress is relatively unstable, it shows a retrogressive situation from 2014 to 2016. Great progress was made from 2016 to 2017, however, although the Innovation Capability is still continuously improving after 2017, the industrial development has the same trend as the national Innovation Index, and it's gradually slowing down.

Table 1. China and South Korea's innovation capability and global ranking of innovation index.

Year	Country	Innovation Capability	Innovation Index
2014	China	19	29
	South Korea	4	16
2015	China	22	29
	South Korea	1	14
2016	China	21	25
	South Korea	1	11
2017	China	17	22
	South Korea	1	11
2018	China	19	17
	South Korea	1	12
2019	China	16	14
	South Korea	1	11

Based on the above statistics, firstly, as an advanced form of industrial cluster, national Innovation Industrial Cluster has greatly promoted the improvement of economy, industry, science and technology and national Innovation Capability in recent years. Secondly, although China's innovation ability still maintains its development trend, the actual industrial situation has a certain stagnation period. Finally, through literature research, with the development on scientific and technological innovation, as well as the focus of the Fourth Industrial Revolution on information technology and artificial intelligence, China's industrial layout has undergone major adjustments, and China should continue to explore new innovation models to maintain the growth of the country's innovation capability. Exploring the construction of Science and Technology Industry Innovation Cluster is precisely in line with China's current development needs.

3.2. The Development Demand of Innovation Industry for Science and Technology Innovation Cluster

During the 13th Five-Year Plan period, China put forward a macro-development strategy of promoting industrial development through scientific and technological innovation. Under the guidance of the policies, the market gradually develops the tertiary industry with the trend of 5G, artificial intelligence, big data and other high-tech technologies, which greatly promoted the economic and social development of China. The growth rate of the tertiary industry in China was relatively fast before 2010, but it slowed down after 2010. This performance reflects that although China's national economic science and technology has been promoted with the help of Industrial Clusters and Innovation Clusters, the development is still declining as the world's overall innovation capacity has improved. Therefore, while stabilizing the development of Industrial Clusters and Innovation Clusters, our country urgently needs

to explore a new innovative development model to promote the improvement of national innovation and ensure the steady development of economy, industry and technology.

The Science and Technology Industry Innovation Cluster has the characteristics of high technology, high growth rate and high employment rate, and it also has the foresight and advancement of science and technology development, which is highly consistent with China's current strategy. In addition, Macao has similar resource endowments with South Korea. Therefore, this research first discusses the construction of South Korea's Science and Technology Industry Innovation Cluster from a national perspective, and then discusses the feasibility and necessity of constructing the Science and Technology Industry Innovation Cluster from Macao's regional perspective.

3.3. Feasibility of Macao's Science and Technology Industry Innovation Cluster Development

Macao's natural resources are similar to those of South Korea. Limited by land resources, labor resources and some other conditions, both places use the tertiary industry as the main driving force for economic development. In addition, the government of Macao and the government of South Korean strongly advocate industrial innovation and development.

Macao is located in the Guangdong-Hong Kong-Macao Greater Bay Area (GBA), and it is backed by developed manufacturing areas such as Shenzhen, Hong Kong and Guangzhou. It faces the international market and has close ties with Portuguese and countries along the Belt and Road (B&R) initiative. As a result, Macao has great advantages in resource integration. As an important force in the construction of Macao's Science and Technology Industry Innovation Clusters, the role of many Macao universities, including the University of Macao and the Macao University of Science and Technology, cannot be ignored. In terms of scientific research exchanges with foreign countries, Macao has a large number of top scholars such as academicians of the British Royal Academy of Engineering and IEEE scholars. What's more, Macao has made many remarkable achievements in the fields of materials, artificial intelligence and electronics, and has set up a number of key scientific research centers.

4. The Research of South Korea's Science and Technology Industry Innovation Clusters

4.1. Demands of Development

In the post-financial era, South Korea's Catch-up economic strategy is facing a bottleneck. Firstly, because the global economic downturns, South Korea's economic growth rate falling from 4%-5% at the beginning of the 21st century to 2.6% in 2013, the development of traditional advantageous industries such as shipbuilding and semiconductor gets weaker, and the efficiency and vitality of the enterprise get reduced, which limit the investment and capability of enterprise's research and development. Secondly, in technologically advanced countries, the awareness of intellectual property rights has been raised and technology exports are relatively small. In view of the above reasons, South Korea has adjusted its national development route, formulated the *Leading* strategy and made technologies such as ICT in the Fourth Industrial Revolution the main area for economic development.

Under this background, South Korea has constructed Science and Technology Industry Innovation Clusters in a short period of time through upgrading and transforming traditional Industrial Clusters and re-distributing science and technology industries. At present, South Korea has formed 16 Science and Technology Industry Innovation Clusters such as *Banqiao Technology Valley* and *Dade Science City.* These clusters have effectively promoted its national innovation and industrial competitiveness and promoted the development of South Korea's national economy, industry and technology.

4.2. The Support of Policies

In 2013, South Korea established the *Creating Economic Development Strategy* as the country's first economic strategy, and Information & Communication Technology (ICT) as the country's future development direction. It issued the *Medium-and Long-Term Strategy for ICT Research and Development (2013-2017)* to create an economic ecosystem, promote the development of ICT and integrate applications in various industries. Since then, South Korea has issued targeted industrial

stimulus programs such as the *National Innovation Strategy in the Fourth Industrial Revolution Era*. At the same time, macro policies are often accompanied by a number of implementation plans, and the whole thing is focused on the science and technology field (table 2).

Table 2. South Korea's science and technology industry development policy route.

Year	Name	Object	Content	Subsidy Policies
2013	Creating Economic Development Strategy	Establish the national first economic strategy for science and technology industry.	From *Catch-up* strategy change to *Leading* strategy	*2013* Innovation Development Plan
2014	The Sixth Industrial Technology Innovation Plan	Establish the national development direction of ICT technology industry and technology.	Make ICT deeply integrate with technologies in various fields.	Medium-and Long-Term Strategy for ICT Research and Development (2013-2017)
2015	Nine National Strategic Projects	Re-adjust the layout of national industries.	Establish 10 core technologies, 9 national industries.	ICT 2020 (K-ICT 2020) (2017-2020)
2017	National Innovation Strategy in the Fourth Industrial Revolution Era	Focus on ICT Frontier Technologies of the Fourth Industrial Revolution.	Carry out a global development survey and formulate development plans for key technology areas.	Technical Survey Report of the Fourth Industrial Revolution

4.3. Regional Division

According to table 3, first of all, South Korea's Science and Technology Industry Innovation Clusters attach great importance to the original regional industrial foundation. South Korea has clearly divided and planned the future Science and Technology Industry Innovation Clusters according to the city location and the traditional Industrial Clusters. Secondly, apart from the ICT industry, the development of manufacturing industry has not been abandoned. At present, the clusters in South Korea's Chonnam, Chonbuk and Ulshan still mainly focus on manufacturing industries such as heavy industry. South Korea regards regional advantages and foundations as the criteria for dividing the construction of Scientific and Technological Industry Innovation Clusters. On the one hand, it reflects the reliance on regions. On the other hand, building new clusters on the basis of traditional industrial clusters helps to reduce waste of resources, shorten the time and enhance the innovation capability in the short term.

Table 3. Regional division of South Korea's science and technology industry innovation cluster.

Name	Key Direction of Industrial Development
Seoul	Cultivate Northeast Asian Business and build IT-BT Industry Base
Inchon	Cultivate Northeast Asian Portal Cities
Gwangju	Build Optoelectronic Industry Cluster
Ulshan	Petrochemical, Shipbuilding and Automobile Industry Complex
Chonbuk	Build Clusters of Automobile Machinery Industry
Chonnam	Foster industries such as shipbuilding

5. Conclusions and References for Macao

5.1. Rationalize the Regional Layout

Science and Technology Industry Innovation Cluster is the main mode of development in South Korea. According to the construction experience of South Korea's clusters, firstly, the emergence of the Science and Technology Industry Innovation Cluster is an inevitable result of the Fourth Industrial Revolution and the development of global innovation trend. Although there is no large-scale construction wave in the world at present, it is bound to be widely paid attention to as the demand for innovation develops. Therefore, China, especially Macao, should develop this model in advance.

Secondly, although Science and Technology Industry Innovation Clusters are different from Industrial Clusters and Innovation Clusters, according to South Korea's experience, the construction should be reformed and upgraded based on the advantages of Industrial Clusters and regional development so as to reduce costs and control investment. According to the advantages and characteristics of Macao's various regions, a reasonable division of scientific and technological industrial innovation clusters should be formed.

5.2. Strengthen the Support of Policies

At present, with the development and construction of Hengqin New District, Macao is facing new development opportunities. It's vital to actively develop and utilize Hengqin New District, attract top scientific research institutions and talents from the world, and jointly build Macao's Science and Technology Industry Innovation Cluster. At the same time, the Macao government can increase the attraction of Macao's science and technology industry through the introduction of a variety of policies such as talent introduction policy and high-tech industry investment policy, so as to take advantage of the development opportunity of the Belt and Road (B&R) initiative to vigorously introduce advanced high-tech enterprises to settle in, form a large-scale science and technology industry and build a cluster. In addition, to promote the transformation of scientific research achievements into real productive forces is an important task for Macao to cultivate large-scale scientific and technological industries and build Science and Technology Industry Innovation Cluster. The B&R has triggered the flow of capital, talents and technology around the world, which has also provided great convenience for Macao to carry out international technology trade and technology exchange activities. Through the integration of resources within the region and the flow of technology between regions, Macao can realize the rapid development of scientific and technological innovation and construct Science and Technology Industry Innovation Cluster.

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