Building Science and Technology Innovation Centre in Beijing Should Care about Industry Application

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Abstract. With the continuous advancement of innovation globalization, innovation in science and technology has become an important way to implement national strategy and achieve sustainable development, and the role of science and technology innovation centre has become more and more obvious. In the new era, the Science and Technology Innovation Centre takes innovation drive as the development goal, based on the metropolis or urban agglomeration, and promotes the coordinated development of science-technology-industry. It is an innovative ecosystem that takes the role of source, agglomeration, radiation and leading functions. This paper constructs an evaluation index system from the aspects of scientific and technological innovation investment and scientific and technological innovation output, and evaluates 12 provinces with relatively leading scientific and technological innovation. Among them, Beijing leads the country in terms of scientific and technological output, and is relatively insufficient in terms of industrial innovation output. In this regard, it proposes to do a good job in top-level design of industrial planning, strengthen the ability of independent innovation of enterprises, and improve the ecological construction of industrial services.

1. Introduction
With the continuous promotion of technological innovation, globalization has developed towards globalization after production globalization and service globalization. The innovation elements such as talents and finance have flowed on a global scale. Science and technology competition has become an important challenge all countries faced with, and it has also seized the highland of innovation. Therefore, it has become the policy choice of all countries. On this basis, in April and September 2016, the State Council issued a document to propose action plans for Shanghai and Beijing Construction Technology Innovation Centre. As the national capital, Beijing occupies an important position in the national innovation system and undertakes the task division of building a national science and technology innovation centre. However, what is the connotation of the science and technology innovation centre, what are the shortcomings of Beijing as a national science and technology innovation centre and what areas do you need to continue to work on will be considered and explored in this paper on the basis of analyzing the connotation of science and technology innovation centres.

2. The connotation of science and technology innovation centre
Regarding the Science and Technology Innovation Centre, there is no authoritative definition of this in the academic world. All scholars have their own perspectives and their respective starting points, including the distinction between technological innovation links from the perspective of the innovation chain, from a regional perspective to the country and region. Different levels such as cities and cities [1-4], but this kind of diversification has not reached the consensus of the academic community on the connotation of science and technology innovation centres. Beijing, Shanghai and other places have proposed different construction ideas and plans from the practice of building a science and technology innovation centres.
innovation centre. At the same time, Guangzhou, Shenzhen, Qingdao, Wuhan, Chengdu, Ningbo and other places have also provided valuable experience in technological innovation and industrial innovation. If we divide the construction connotation of the science and technology innovation centre from the perspective of the innovation chain, then what can be the science and technology innovation centre could be answer from the five aspects.

2.1 The geographical scope of the Science and Technology Innovation Centre is in a metropolis or a city group.

The geographical scope of the Science and Technology Innovation Centre has rarely appeared in previous studies. However, according to the successful experience of Silicon Valley in the United States, many countries have realized technological innovation through the construction of science parks through the agglomeration of universities and research institutions, such as the United Kingdom, Japan, South Korea, Singapore and Taiwan. But the technology park also has its own shortcomings. Some parks are located in the suburbs, away from the city centre, and are not easy to communicate with other regions in terms of talent, capital, market, and circulation. Although the development model centred on the technology park is still not completely outdated, the city-centred development model has also begun to try. After the 2008 financial crisis, the United States built "Silicon Lane" in New York, relying on New York's national metropolitan status and developed knowledge-intensive service industries to develop high-tech companies such as the Internet, new media, network technology, and information technology, surpassing Boston to become a nationwide The second largest technology centre represents a bright future for science and technology innovation centred on cities.

According to the research of Shanghai Institute of Science and Technology Information, the development process of the existing science and technology innovation centres in the world can be roughly divided into four paths, including: 1 to the science and technology innovation centre, such as Silicon Valley; 2 from the trade centre, financial centre to technology Innovation centres, such as New York and London; 3 from science innovation centres to science and technology innovation centres, such as Zengbo, Boston, and Cambridge; 4 from improving regional science and technology innovation systems to technological innovation centres, such as New York, London, and Berlin. Even different paths can be developed simultaneously [5]. However, from the perspective of foreign development, Silicon Valley, which is developed in the technology park mode, is still the largest technology centre in the United States, but it is already behind in terms of market and finance. Both the Financial Times and The New York Times commented on the “Echo Room” phenomenon in Silicon Valley, arguing that innovation and entrepreneurship exchanges in Silicon Valley led to a lack of targets in the US market. In addition, from the number of employees in the financial technology industry (FinTech) in London, New York and Silicon Valley, Silicon Valley is only 11,000, behind London (44,000) and New York (43,000). In addition, Mou Q.H (2016) also starts from the availability of innovative resources, and believes that the model of metropolitan or urban agglomerations and urban belts as technological innovation centres can alleviate the problem of excessive cost of innovation resources such as talents, capital, and services [6]. Some large US companies have moved their headquarters back to the metropolis, such as the General Electric headquarters in Boston, and Motorola Solutions Inc. in Chicago, which is also a reflection of this trend.

2.2 The goal of the Science and Technology Innovation Centre is to implement a national innovation-driven strategy

The world today is gestating a new round of scientific and technological revolution and industrial transformation. The new economic model with data as the production factor is reshaping the global economic structure and competitive advantage. Since the 18th National Congress of the CPC, the CPC Central Committee, with General Secretary Xi Jinping as its core, has put forward the strategy of innovation-driven development, emphasizing that scientific and technological innovation should be placed at the core of the overall development of the country. In the report of the Nineteenth National Congress of the Communist Party of China, innovation has been mentioned more than 50 times,
involving all aspects of innovation-driven and innovative nation-building, especially emphasizing that innovation is the strategic support for building a modern economic system.

Building an innovative country and realizing innovation-driven development is the strategic task of realizing the great rejuvenation of our nation. Building a science and technology innovation centre is the important guarantee of the national innovation-driven strategy. The National Science and Technology Innovation Centre undertakes the national will and regional strategy, which is the historical mission entrusted by the state and the concentrated embodiment of the national innovation driving strategy. Therefore, the goal of the Science and Technology Innovation Centre must be to implement the national innovation-driven development strategy, give full play to the inherent supporting role of science and technology in the economy, and realize the leap-forward development of science and technology and economy.

2.3 Science and Technology Innovation Centre realizes the synergistic and progressive innovation of science-technology-industry

Based on the study of the World Science Centre and its transfer laws, it could learn that the scientific centre exists objectively in a certain period of time, leading the rest of the world in scientific output, and shifting with the scientific revolution [7]. Technological innovation focuses on application and is the process of applying knowledge to the market and exchanging knowledge for wealth. Schumpeter’s innovation theory is also mentioned as an important component of the five innovation models. Industrial innovation has received attention from Schumpeter's product innovation, technology innovation, market innovation, resource allocation innovation, and organizational innovation, and is recognized as an important source of sustained economic growth. From the perspective of the scientific development of Britain, Germany, and the United States in modern times, the basic scientific exploration and the research and development of technology are inseparable. At the same time, the industry is constantly iteratively upgrading based on the development of science and technology. Therefore, from the perspective of the innovation chain, scientific innovation-technical innovation-industry innovation is developed in a coordinated manner. It is believed that the scientific and technological revolution originated from new discoveries in science and broke through in the basic field. After that, the use of technology to create innovation is an innovative breakthrough in production methods. After technological innovation, new technologies generate new products, trigger a new round of industrial transformation, and achieve industrial innovation.

These views have important value for the definition of the meaning of our science and technology innovation centre. But researchers also need to pay attention to the impact of differences in national conditions and institutions on technological innovation. For example, for the development and application of science and technology, there are differences in the division of labor between innovations at home and abroad. Compared with schools and research institutions, foreign companies play more role in pilot development and commercial application. However, to some extent, there are phenomena in which application technology is accumulated in schools and research institutes, which is difficult to be discovered and used by enterprises. However, China also has the initiative of universities and research institutes to promote the transfer of scientific and technological achievements, and has become an important supplement to the cooperation between government and industry. Therefore, the connotation of China's science and technology innovation centre should focus on the organic combination and interactive development of science, technology and industry, that is, the synergistic and progressive innovation of science-technology-industry.

2.4 Science and Technology Innovation Centre undertakes the source of innovation, agglomeration, radiation, and leading functions

The source function refers to the fact that the science and technology innovation centre is often the innovation source and production centre of new knowledge, new technology, new products and new industries in a region, a country and even the whole world. This is its most fundamental function. There are also some people believes that an innovative central city with the ability to promote the
application of large-scale innovation is the real source of industrial innovation. The city's innovative source function is based on the city's pivotal position[8]. However, this view emphasizes industrial innovation and ignores the scientific innovation and technological innovation that science and technology innovation centres should undertake. Therefore, the source function still needs to be comprehensively promoted in science, technology and industry.

The agglomeration function refers to the concentration of various innovation resources, innovation elements and innovation activities into the innovation centre, and exerts the agglomeration effect, resulting in the effect of 1+1>2. The agglomeration here can be agglomeration in physical space, such as incubator, crowd-creating space, etc., for service gathering of small and medium-sized start-up enterprises, or it can be agglomeration in virtual space, such as various Internet platforms to gather various supply and demand information, realize innovative resources and The precise docking of the elements. At the same time, the gathering of innovative talents and innovative activities brings about innovation atmosphere and changes in cultural environment, which is an important supplement to the self-organization development of science and technology innovation centres.

The radiation function refers to the fact that the Science and Technology Innovation Centre has strong competitiveness to the surrounding and external regions, mainly through the competition and cooperation of related entities. The innovative subjects that realize the radiation function include universities, research institutes, high-tech enterprises, and even public policy institutions, which can influence other subjects in many aspects such as science and technology, economy, society, politics and culture. The level of radiation function is the embodiment of the competitiveness of related subjects, representing the quality of the output of the Science and Technology Innovation Centre. Radiation function is an important part of the realization of functional closed-loop. On the one hand, it spreads knowledge, information, services, and even talents, capital, and products to the periphery. On the other hand, it attracts the accumulation of these innovative resources and elements through competitive advantage.

The leading function refers to the ability of the Science and Technology Innovation Centre to promote technological innovation and industrial innovation at the regional, national and global levels by coordinating various innovation factors and innovation activities, which is a direct reflection of the influence of the science and technology innovation centre. On the one hand, science and technology innovation centres need to be the forerunners to achieve innovation-driven development in various places, and explore measures and paths to promote scientific innovation, technological innovation, and industrial innovation. On the other hand, as an important hub of the national innovation network, the science and technology innovation centre needs to coordinate the innovation resources of different cities, realize the complementary advantages of different cities and regions, and promote the coordinated development of the region.

2.5 The Science and Technology Innovation Centre is an innovative ecosystem consisting of innovative entities, supporting institutions, and an innovative environment.

The main players of innovation include the government, universities, research institutions and high-tech enterprises. The government is the main body of institutional innovation and an important guarantee for the innovation of the ecological environment. Universities and research institutes are the mainstay of technological innovation and an important support for innovative resources such as human capital and experimental equipment. High-tech enterprises are the market mainstay of technological innovation application, and also the link between market and innovation. They are responsible for the main body of innovation decision-making, the main body of R&D investment, the main body of scientific research organization, and the main body of results transformation.

Auxiliary institutions consist of technology services, financial services, and some industry support systems. The science and technology service industry is an important auxiliary institution. It provides scientific and technological services such as R&D and design, technology consulting, technology trading, business incubation, and technology finance for the main body of innovation. It is an important link connecting the development, transformation and application of scientific and
technological achievements. Financial service institutions undertake market discovery functions and are also an important force in safeguarding industrial development. Industry support system includes industry standard system, industry credit system, intellectual property management system, public service system, etc.

The innovation environment includes innovative infrastructure such as information networks, laboratories, libraries, and databases, as well as an ecological environment consisting of markets, laws, policies, cultures, organizational structures, and institutional mechanisms. A good innovation ecological environment is an important guarantee and inevitable outcome of the formation and development of science and technology innovation centres.

In summary, the science and technology innovation centre is based on the metropolitan area or urban agglomeration, with innovation as the development goal, and realizes the synergistic and progressive innovation of science-technology-industry. It also undertakes an innovative ecosystem of policy, agglomeration, radiation, and leading functions.

3. Evaluation index system design
The construction of Beijing National Science and Technology Innovation Centre not only needs to provide guidance in theory, but also establish a relatively accurate and perfect evaluation index system to reflect the connotation and value of Beijing's national science and technology innovation centre. Based on the functional components of the Science and Technology Innovation Centre's Science Sub-centre, Technology Sub-centre, and Industrial Innovation Sub-centre, we constructed a technological innovation with two levels of indicators based on evaluation of objectivity, representativeness of indicators, and availability of data. Centre construction evaluation index system. Among them, there are two first-level indicators, including scientific and technological innovation investment and technological innovation output. There are 9 secondary indicators, including the R&D expenditure intensity of the whole society, the number of R&D personnel per 10,000 people, the number of state-level technology incubators, the employment of urban units in the science and technology service industry, the number of scientific and technical papers published by thousands of people at home and abroad, and the number of patents granted for inventions, the proportion of technical transaction contracts to the proportion of local GDP, the total industrial output value of high-tech enterprises, and the amount of foreign exchange earned by high-tech enterprises. These indicators describe the elements and functional realization of the Science and Technology Innovation Centre from different aspects.

| Table 1 Science and Technology Innovation Centre Construction Evaluation Index System |
|---------------------------------|---------------------------------|
| **First level index** | **Second level index** |
| innovation input | the R&D expenditure intensity of the whole society X1 |
| | the number of R&D personnel per 10,000 people X2 |
| | the number of state-level technology incubators X3 |
| | the employment of urban units in the science and technology service industry X4 |
| | the number of scientific and technical papers published by thousands of people X5 |
| | the number of patents granted for inventions X6 |
| innovation output | the proportion of technical transaction contracts to the proportion of local GDP X7 |
| | the total industrial output value of high-tech enterprises X8 |
| | the amount of foreign exchange earned by high-tech enterprises X9 |

4. Factor analysis model and results
In order to make an objective and accurate evaluation of the construction of the Science and Technology Innovation Centre in Beijing, to clarify its ranking within the major innovative cities of the country, and to define the stage of construction of the Beijing Science and Technology Centre, select 12 cities including Beijing, Shanghai, Guangdong and Tianjin. The domestic and international scientific and technological papers were published, and the regional data of high-tech industries were developed and analyzed horizontally in Beijing. The research data mainly comes from the National
Statistical Yearbook, the China Torch Statistical Yearbook, and the public information of various provinces and cities. Combined with the evaluation index system for the construction of science and technology innovation centres established in the previous article, the 2016 annual data of 12 regions were compiled. The measurement of the construction of science and technology innovation centres is quantified by using nine indicators. Factor analysis is used to extract common factors, and the scores of factors in various regions are sorted to obtain the development characteristics and shortcomings of Beijing relative to other innovative regions in China.

Through the correlation test between variables, it is judged that there is a strong correlation among most of the variables. It can also be seen from the results of the KMO and Bartlett spherical tests that KMO = 0.699 is greater than 0.6. The test results are good and suitable for factor analysis. The principal components are extracted from the variables with the eigenvalue greater than 1. The two principal components F1 and F2 are extracted. The cumulative interpretation rate of the variance of the two principal components to the original variables reaches 91.99%, including most of the original variables. After the factor rotation, it is found that F1 has a large load on X1, X2, X4, X5, X6, and X7, so F1 is named as the science and technology output factor. F2 has a large load on X3, X8, and X9, so F2 is named as an innovative industry output factor. According to the factor score coefficient matrix output by the IBM SPSS 19, each common factor can be expressed as a linear function of each index, and the factor score coefficient is multiplied by the corresponding standardized score to obtain the score of the construction of the science and technology innovation centre in each region.

| Table 2 Component Score Coefficient Matrix |
|-------------------------------------------|
| variable | Component score factor |
|          | F1          | F2          |
| X1       | 0.180       | 0.010       |
| X2       | 0.172       | 0.057       |
| X3       | 0.012       | 0.315       |
| X4       | 0.165       | 0.065       |
| X5       | 0.182       | -0.056      |
| X6       | 0.181       | 0.014       |
| X7       | 0.174       | -0.091      |
| X8       | -0.007      | 0.328       |
| X9       | 0.002       | 0.330       |

The factor score function is as follows:
\[
F1 = 0.180 \times X1 + 0.172 \times X2 + 0.012 \times X3 + 0.165 \times X4 + 0.182 \times X5 + 0.181 \times X6 + 0.174 \times X7 - 0.007 \times X8 + 0.002 \times X9
\]
\[
F2 = 0.010 \times X1 + 0.057 \times X2 + 0.315 \times X3 + 0.065 \times X4 - 0.056 \times X5 + 0.014 \times X6 - 0.091 \times X7 + 0.328 \times X8 + 0.330 \times X9
\]

According to the weighted average of the eigenvalues of the principal components in the total variance table explained, the comprehensive scores of the construction of science and technology innovation centres in various regions can be obtained.

| Table 3 Comprehensive score table |
|-----------------------------------|
| project  | F1 score | F1 rank | F2 score | F2 rank | F score | F rank |
|----------|----------|---------|----------|---------|----------|--------|
| Beijing  | 2.95085  | 1       | -0.49303 | 7       | 2.45782  | 1      |
| Jiangsu  | 0.05249  | 3       | 2.0815   | 1       | 2.13399  | 2      |
| Guangdong| -0.07832 | 5       | 1.91267  | 2       | 1.83435  | 3      |
| Shanghai | 0.60308  | 2       | 0.08552  | 5       | 0.6886   | 4      |
| Shandong | -0.47737 | 8       | 0.25829  | 3       | -0.21908 | 5      |
| Zhejiang | -0.49265 | 9       | 0.0927   | 4       | -0.39995 | 6      |
| Tianjin  | -0.01417 | 4       | -0.58943 | 8       | -0.6036  | 7      |
| Hubei    | -0.46541 | 7       | -0.59804 | 9       | -1.06345 | 8      |
| Shanxi   | -0.18348 | 6       | -0.90325 | 12      | -1.08673 | 9      |
| Anhui    | -0.66617 | 12      | -0.4926 | 6       | -1.15877 | 10     |
| Sichuan  | -0.61288 | 10      | -0.64054 | 10      | -1.25342 | 11     |
| Liaoning | -0.61597 | 11      | -0.71377 | 11      | -1.32974 | 12     |
Judging from the comprehensive score F, Beijing scored 2.46, ranking first in the sample provinces, and far surpassed peers in the evaluation of the construction of science and technology innovation centres. However, the development of Beijing Science and Technology Innovation Centre is not balanced, and the output factor of science and technology is obviously larger than the innovation and entrepreneurial output factor, indicating that Beijing has superior scientific and technological output, but it is relatively weak in industrial innovation.

From the perspective of F1, all indicators have positively promoted F1 except for the total industrial output value of high-tech enterprises (X8). From the perspective of science and technology output factors, Beijing scores 2.95, which is the first in many provinces. This is in line with the reality. As the capital of Beijing, Beijing has gathered most of the universities and research institutes in the country, and a large number of innovative resources have gathered, and the output of science and technology far exceeds that of other provinces.

From the perspective of F2, all the indicators have positive effects on F2 except for the number of published scientific and technical papers (X5) and the proportion of technical transaction contracts (X7). Beijing is in the middle of the ranking and is closely related to the industrial scale of Beijing. However, Beijing should become a national industrial innovation centre rather than a national industrial centre. Therefore, it is necessary to further optimize the industrial structure in the industry, focus on high-tech industries, improve the effective supply of technology transfer and transformation of results, and continuously enhance the international competition of the industry.

5. Conclusion and
In this paper, it could recognize that the science and technology innovation centre is based on the metropolitan area or urban agglomeration, with innovation as the development goal, and realizes the synergistic and progressive innovation of science-technology-industry. It also undertakes an innovative ecosystem of policy, agglomeration, radiation, and leading functions. Beijing undertakes the important task of building a national science and technology innovation centre based on Beijing's original innovation capability and unique resource advantages accumulated in the development of science and technology innovation. Beijing has advantages in science and technology development, but it is relatively insufficient in industrial development. The next step should be to continue to grasp the strengths, make up the shortcomings, and exert strength from the application side to strengthen the construction of the national science and technology innovation centre. In this regard, this paper proposes the following recommendations:

**Pay attention to the top design of industrial planning.** Strengthen the top-level design and guide and promote industrial development through multi-sector cooperation. Increase policy coordination, scientifically guide breakthroughs in technological bottlenecks and regional industrial layouts, and sort out standards and safety regulations. Focus on the development of industrial differentiation, promote the construction of innovation centres, industrial bases, and application demonstration bases, and summarize outstanding cases and development experiences to be promoted nationwide. Strengthen the information communication between the government and enterprises, establish a docking mechanism for the demand for scientific and technological achievements, and realize the effective docking of the industrial chain.

**Strengthen the ability of independent innovation.** Guide high-tech enterprises to carry out technological innovation activities and improve their independent innovation capabilities. Improve the scientific research level of enterprises, enhance the breadth and depth of technological innovation, and continuously upgrade the process and product functions. Strengthen the cooperation between industry, academia and research, and the transformation of military and civilian integration, build a multi-channel and multi-form cooperation platform for production, education and research, and strengthen the process of civilian use of military technology. Improve the quality and quantity of innovative and entrepreneurial services, accelerate the construction of dual-creation facilities and improve the efficiency of utilization, and promote innovation and entrepreneurial institutions to actively meet the needs of enterprises and strengthen the professionalism and effectiveness of dual-creation services.
**Improve the ecological construction of industrial services.** Based on the advantages of Beijing's innovative resources, it should strengthen the guiding role of industrial policies and improve the ecological construction of industrial services from public services and technology services to business environment. Build an innovative platform system and strengthen the supply of innovative services. Guarantee technology research, property rights services, testing and promotion, information exchange, innovation incubation and other services. Strengthen local financial product innovation and talent policy innovation, and strengthen resource integration. Give full play to the functions of political and legal organs, create a business environment that is honest and law-abiding, protect entrepreneurs' enthusiasm for innovation and entrepreneurship, and optimize administrative procedures.

In summary, Beijing should further develop its advantages, grasp the big and let go, accelerate the transfer of results, enhance the ability of industrial innovation, support China's construction into an innovative country, and play a role in demonstrating and driving the nation's innovation-driven development.

**References**

[1] Xiong H.R. (2015) The Formation and Development of Global Science and Technology Innovation Centre. J. Learning and Exploration, 09:112-116

[2] Du D.B. (2016) He Yuhui. The Connotation, Function and Organization Structure of Global Science and Technology Innovation Centre. J. China Science and Technology Forum, 02:10-15

[3] Wang J.N, Bai J, Luo Z.P.(2016) Theoretical Source Tracing, Policy Track and International Mirror of Innovation Centre. J. Reform, 11:41-52

[4] Zhang Y.F.(2017) The Connotation, Function and Management Mechanism of Comprehensive National Science Centre. J. China Science and Technology Forum, 06:5-12

[5] Shanghai Institute of Science and Technology Information, Editor-in-Chief.(2016) Strategic Intelligence Research of the Global Science and Technology Innovation Centre – From “Park Times” to “Urban Times”. Shanghai Science and Technology Literature Publishing Society, Shanghai

[6] Mou Q.H.(2016) Construction of Science and Technology Innovation Centre in “Urban Times”——Dialogue Researcher of Qi Qihao, Shanghai Institute of Scientific and Technical Information.J. Competitive Intelligence, 05:4-9

[7] Zhao K.(2013) Transfer of Science Centre and China's Strategic Opportunity. J. Mao Zedong, Deng Xiaoping Theory, 07:72-77

[8] Tu Q.Y.(2017) Innovation and Expectation of Shanghai New Round Urban Master Plan. J. Shanghai Urban Planning, 04:13-17

[9] Zhao W, Liu W, Li C.L.(2015) Strategic Thinking and Evaluation System of Building National Science and Technology Innovation Centre in Beijing. J. China Development Review, 06:77-81

[10] Han Z.R, Wei J, Zhang W, Song Y.H.(2017) Research on Strategic Path of Industrial Science and Technology Innovation Centre Construction.J. Technology Economics and Management Research, 06:125-128