Research on the Construction of Collaborative Innovation Ecosystem in Hefei's "Innovation Capital"

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Abstract. The collaborative innovation ecosystem belongs to a new innovation management mode, and building a dynamic collaborative innovation ecosystem is an important prerequisite and guarantee of urban collaborative innovation. Based on the theoretical research of collaborative innovation ecosystem and the analysis of its basic characteristics and operating mechanism, the paper constructs the innovation ecosystem model of Hefei National Science Center based on the theory of symbiosis, and makes a concrete analysis of the operation mechanism. Finally, the specific safeguard measures of constructing a collaborative innovation ecosystem are discussed in connection with Hefei.

1. Introduction
Cities are the spatial carrier of innovation (Lu Rachan et al., 2015). In the current era of knowledge economy, regional innovation is gradually changing to a systematic and networked paradigm, and regional collaborative innovation has emerged in this context. Collaborative innovation network is an important carrier of urban collaborative innovation, while collaborative innovation ecosystem is an important prerequisite and guarantee of urban collaborative innovation. January 1, 2017, Hefei Comprehensive National Science Cente pass national give an official, it marks that Hefei will become an important force to represent the country in the world's scientific and technological competition and cooperation. As a result, Hefei will create an "innovation capital" with world influence. As the material basis of collaborative innovation, the collaborative innovation network is an important material carrier for the improvement of Hefei’s comprehensive innovation ability, and to build a scientific collaborative innovation network, it is necessary to have a perfect collaborative innovation ecosystem to ensure. Therefore, the construction of a new cooperative innovation ecosystem is an important part of the construction of Hefei's "Innovation Capital".

2. Analysis of Collaborative Innovation Ecosystem Theory
2.1. The Basic Concept of a Collaborative Innovation Ecosystem
At present, the academic circles have not yet formed a unified conclusion on the collaborative innovation ecosystem, and the scholars analyze the collaborative innovation ecosystem from the
macro, medium and micro levels, as well as related elements and characteristics. In an article in Eco Strategy, Harvard professors Marco Iansiti and Levien point out that ecosystems are a loose network of suppliers, outsourcers, distributors, product manufacturers, technology providers, etc. Autio and Thomas point out that the collaborative innovation ecosystem consists of core businesses and core platforms. Include participants on both sides of the demand and supply sides, and create new-value interconnections through innovative activities. In addition, Jackson points out that in a collaborative innovation ecosystem, people interact with the communities of the organizations to create and use innovative ecological networks. Domestic scholars Hui Xingjie, Li Xiaohui, Luo Guofeng and so on (2014) believe that the collaborative innovation ecosystem is a complex system with interaction, interlink age and initiative of various elements. Li Wan, Chang Jing, Wang Minjie, etc. (2014) emphasize that the collaborative innovation ecosystem is a dynamic system formed by energy exchange, material exchange and information exchange between various innovative communities and environments in a certain interval. The concept of an innovation ecosystem was put forward in 2003 by the U.S. Presidential Council of Science and Technology Advisory Boards by summarizing the Silicon Valley experience. Combining the views of many scholars at home and abroad, the collaborative innovation ecosystem can be defined as: between various innovative communities in a region and between the innovation environment, through the connection and conduction of material flow, energy flow and information flow, the formation of symbiotic competition, dynamic evolution of open and complex system.

2.2. Basic characteristics of a collaborative innovation ecosystem

The basic characteristics of a collaborative innovation ecosystem can be summarized in the following ways:

First, the elements and subject characteristics: (1) the various environmental elements of the collaborative innovation ecosystem are interactive with other elements. Similar to biological ecosystems, the process of collaborative innovation is the interaction between species, communities and ecological environment. In this system, the main elements of government, universities, enterprises and scientific research institutions are regarded as species in the system, obtain the necessary "feed" from the material and human resources in the environment, maintain the balance between communities through competition, cooperation and symbiosis, and interact with cultural, economic, geographical and other factors. (2) System of supply and demand. The collaborative innovation ecosystem covers a wide range of organizational communities, individuals and institutions, such as regulatory bodies, coordinating bodies, scientific research institutions, educational institutions, financial institutions, the judiciary, competitors and complementary groups, and involves a large number of stakeholder groups or individuals, including the supplier and demand side of complementary assets, with comprehensive and systematic characteristics. The system is different from the traditional industrial network, demand network, cluster network, etc.

Second, the structure and boundary characteristics: (1) the multi-level nature of the structure. Collaborative innovation exists in the form of networks, and the ecosystem of collaborative innovation is interrelated and complementary from a large number of elements, and gradually evolves into a structured network organization, with members of the system relying on other members of the same system to survive and develop, which is more advantageous than traditional bilateral cooperation. In the collaborative ecosystem, the relevant business layer promotes the development of various elements from the center to the periphery by extending inward or outward to the more extensive network space, and this hierarchical network layout structure reveals the evolution mode and complementary function of the subject and environment, and provides optimization and coordination scheme on this basis. (2) Blurred borders. Because of the dynamic characteristics of the collaborative innovation ecosystem itself, the innovation subject and its elements within the system have a certain degree of complexity, and at the same time make the boundary of the system appear blurred. Santos and Eisenhardt emphasize that ecosystem boundaries must be defined by organizational capacity specialization and discourse. Anderson points out that the experience of the main element and the network structure
characteristics of the innovation ecosystem determine the network vision of the system, and the network vision reflects the main element, which affects the definition of the system boundary. Therefore, the boundary of the collaborative innovation ecosystem shows the characteristics of uncertainty and ambiguity, based on this, the innovation ideas and innovative people can be free flow, innovative species continue to flow in and out, and promote the evolution of the system.

Third, the goal and function characteristics: (1) the dynamic elements of self-organization and co-evolution characteristics. The collaborative innovation ecosystem emphasizes the independence and joint development of individuals, and advocates the dynamic convergence and evolution between the main elements and the innovative ecological environment through the efficient sharing of complementary capabilities and resources. (2) The sharing of values and interests. In contrast to the survival motivations of natural ecosystems (as shown in Table 1), collaborative innovation ecosystems are dominated by the production of innovative products and services, with the aim of achieving value creation and value-added. In this system, the internal members of the system are jointly responsible for the operation of the system. Therefore, all kinds of main elements should be based on the conditions of complementary technology, professional ability and so on under the premise of win-win situation, innovative and consistent solutions, so as to promote the overall prosperity of the innovation ecosystem and the interests of the main body within the system growth.

Table 1. Comparison of natural ecosystems with collaborative innovation ecosystems.

| Essential Features | Nature Ecosystem | Innovation Ecosystem |
|-------------------|------------------|---------------------|
| Factor and Mainstay | Comprised of biological and biomes such as environmental factors (temperature, air, light, soil, moisture), producers, consumers, and decomposers | Environmental elements such as infrastructure, geographical location, innovation culture, policy support, and innovation subjects such as universities, enterprises, scientific research institutions, governments, etc. |
| Structure and Boundary | In spatial structure, including horizontal mosaic, vertical hierarchy and time succession of different biomes | Usually with the core enterprise (or platform) as the center of the framework construction, based on the complementarity of the elements to form a multi-level network structure from the center to the periphery, its boundary ambiguity and liquidity characteristics can promote the free flow of innovative elements |
| Objective and Function | The self-organization, adaptation and self-sustainment of natural ecosystems are realized by using selection, variation, reproduction, evolution, etc. to realize the flow of matter and energy and to transmit basic information. | Continuously improve production efficiency through technological change, enterprise creation, market competition, and strategic customization to maintain the healthy development of the market |

2.3. Analysis of the operating mechanism of collaborative innovation ecosystem
The Operating Mechanism of Collaborative Innovation Ecosystem can be divided into the aggregation mechanism, the competition and symbiosis mechanism and the transmission and diffusion mechanism (as shown in Figure 1).
First, the aggregation mechanism. The establishment and development of a collaborative innovation ecosystem begins with the convergence of innovative resources and organizations. In the early stage of the development of the innovation industry, innovation organizations made breakthroughs in the fields of technology and knowledge and became the leaders of the population, thus attracting the gathering of other innovative resources and organizations and promoting the establishment and development of collaborative innovation ecosystem. At the same time, the knowledge spillover effect, attract other innovative organizations into this innovative industry, expand the scale of the industry. In addition, there is greater uncertainty in the initial stage of industrial development, and innovation resources are difficult to obtain, but when the innovation organization has made some breakthrough, the development potential of the industry is stimulated, the decision-making and coordination in the innovation ecosystem begins to intervene, human resources, policy resources, information resources, economic resources, etc. begin to gather in the system. Promote the continuous flow of system resources, so as to build a good innovative ecological environment.

Second, competition and symbiotic mechanism. There is a complex relationship between competition and symbiosis in the ecosystem of collaborative innovation. As with natural ecosystems, competition and symbiosis play an important role in the operation of collaborative innovation ecosystems. In this system, the competition mechanism is generally the intra-population competition, which is characterized by the inhibition activities carried out by innovative organizations with the same or similar objectives in order to obtain innovative resources. Through intense competition for resources, the successful party can develop, the failed party is forced to transform or eliminate to adapt to industrial innovation. Whether successful or unsuccessful, the competition mechanism greatly enhances the viability and environmental adaptability of innovative organizations.

Third, the conduction and diffusion mechanism. In natural ecosystems, material energy is transmitted step by step through the food chain, laying the foundation for the development of species. In the ecosystem of collaborative innovation, this process is characterized by the transmission of knowledge and the diffusion of innovative technologies, which is also an important mechanism for the operation of the system. Knowledge is an important energy of innovation industry, and with the transfer, transmission and transformation of knowledge, the level of innovation within the collaborative innovation system is constantly improved. Because of the uneven development of innovation organization, the potential energy caused by knowledge difference can promote the flow of knowledge from high-level innovation organization to low-level innovation organization, and gradually form knowledge to network. The diffusion of innovative technology is an important way to realize industrialization, and the dominant innovation individual or organization in the collaborative innovation ecosystem obtains the core technology of the industry through technological innovation, thus establishing the standard of using the technology. Through the diffusion of innovative technology,
the collaborative innovation ecosystem can establish a multi-level innovation technology system, which will promote the rapid development of innovation industry.

3. Construction of the Innovation Ecosystem of Hefei National Science Center based on Symbiotic Theory

3.1. The symbiotic theoretical model of urban innovation

Urban innovation ecosystem is the symbiotic coexistence of innovation ecosystem from the ecological perspective of analyzing the innovation activities and processes of the region, and the interaction of natural ecosystem dynamic situation is compared. Symbiosis theory is an important part of ecology, which can reveal the phenomenon of group interaction, co-existence and co-evolution between different species. Symbiosis theory emphasizes that species can only gain a dominant position in the population and promotes the continuous evolution of the species when they establish complementary partnerships with other related species. The ecosystem of collaborative innovation has always developed with the development of the relationship between the main body of internal cooperation, and followed the law of self-organization development and evolution. The urban collaborative innovation ecosystem under the symbiotic perspective consists of five parts, including symbiotic unit, symbiotic matrix, symbiotic platform, symbiotic network and symbiotic environment. The symbiosis of urban innovation ecosystem not only manifests itself as the interaction between symbiotic units, but also includes the exchange of resources, the flow of energy, the evolution of relationships and the overall effects of comprehensive interaction. Therefore, from the perspective of all elements interdependence, mutual matching and symbiotic interaction, the symbiotic situation of regional innovation ecosystems can be fully reflected, the theoretical model of which is shown in Figure 2.

Figure 2. Urban innovation ecosystem model based on symbiosis theory.

Among them, the symbiotic unit is the basic condition of forming symbiotic, is the "life body" of the ecosystem, and is also the participant of the innovation activities, as long as it includes the enterprises, universities and research institutions involved in the innovation activities. The symbiotic matrix is the necessary condition for symbiosis, the basis for carrying out innovative activities (including scientific research personnel and scientific research funds, etc.), and its different attribution and limited scarcity make it necessary for the symbiotic unit to interact and produce symbiotic
network; It provides a special interface and carrier for innovation activities, so that they can be carried out smoothly in specific "places"; Symbiosis network is the sum of the interaction and links between the symbiotic units of the innovation ecosystem, and it is the relationship capital formed by the cooperative and innovative behavior of the ecosystem symbiotic unit with the purpose of value creation. The symbiotic environment is an important external condition, which provides guarantee for the formulation of symbiotic unit action strategy and the flow of symbiotic matrix, and promotes the change and reconstruction of the content and form of symbiotic network. In a word, in the innovative ecological symbiosis, the coordination, dynamic interaction, co-existence and benign matching between the five symbiotic elements stimulate the symbiotic effect of regional innovation ecosystem.

3.2. Construction of innovative ecosystem model of Hefei National Science Center

The model of the innovation ecosystem of Hefei Comprehensive National Science Center is to construct the innovation ecosystem of five innovation units, including government, enterprise, university, research institute and science and technology intermediary service institution. Within this innovation ecosystem, a horizontal information-sharing network is built to bring together innovative resources and exchange knowledge and information (see Figure 3). In this huge innovation ecosystem, the main body is the community of industry, innovation platform and government, its core function is to promote the knowledge innovation and technological progress of enterprises, while the innovation platform provides intellectual support for knowledge innovation, and an effective process of knowledge capitalization needs a government organization that can span many fields and interests. By constructing the ecosystem of knowledge-collaborative innovation, we form the interaction of official, production, learning, research and inter-collaboration, and realize the urban collaborative innovation effect of "the whole is greater than the sum of the places".

![Figure 3. Model of the innovative ecosystem of Hefei national science center.](image)

As the "innovation capital" of Hefei, the typical characteristics of the innovation ecosystem can be summarized as "five high": first, high-abundance of innovative resources, second, high frequency active innovation subject, third, high-efficiency innovation services and government governance, fourth, high-quality innovation and entrepreneurial environment, and fifth, high-level innovation achievements in the science and technology industry. The "five-height" feature is not separated from
each other, but rather the relationship between interrelation, interaction, mutual matching and mutual promotion, which is essentially a holistic innovation system. To build Hefei "innovation capital" is undoubtedly grand system engineering. To this end, we must be good at systematic thinking, establish systematic consciousness. In such an ecosystem, some belong to the micro-subject function and micro-level operation, and some because of the externality of the need for the government to assume the function from the macro level and operate it. Therefore, cultivating the innovation ecosystem is the key point of Hefei government's efforts to promote the construction of "Innovation Capital".

4. Hefei System Promotes Comprehensive Innovation Reform Experiment: Building an Innovative Ecosphere

In recent years, Hefei System has promoted the experiment of comprehensive innovation reform -- the construction of an "innovation capital" innovation ecosystem. Hefei City to implement the national task of deepening the reform of management and clothing, optimize the dual-creation environment, promote all kinds of social groups to enjoy the policy dividends, the implementation of positive and effective initiatives.

First of all, Hefei in the promotion of decentralization of government, investment approval reform, timely delegation of approval authority. The implementation of classification "slim approval", the approval of social investment projects decreased by 12, the streamlining rate reached 47.8%, the social investment project spending was reduced to 2 categories, the government investment projects compressed the approval time limit, the implementation of "missing approval", the implementation of "7 plus 20". The approval of innovative social undertakings, the introduction of the "Public Welfare Project Process Optimization Implementation Opinions", the implementation of "included in the plan as the same project" and "preliminary design of projects can be studied" and other reforms, to explore education, health projects by the administrative departments approved the audit system. Establish a unified online approval and supervision platform for investment projects in the city.

Secondly, in relaxing the restrictions on access and further deepening the reform of the investment system, Hefei's innovative government and social capital cooperation model has not only introduced the Implementation Opinion on The Investment and Financing Mechanism for Innovation Focus Areas to Encourage Social Investment, but also strengthens private investment, but also actively promotes the PPP model of government and social capital cooperation.

Third, in the implementation of fair supervision, speed up the construction of the after-the-fact supervision system, Hefei to further implement the social credit code reform. Municipal Development and Reform Commission and other departments in the project filing and other work, the unified social credit code as the only identification code. Continuously carry out the "seven-day double publicity" work, has covered all counties (cities) districts, development zones, accumulatively to "credit China" "credit Anhui" real-time report double publicity information more than 391,000.

Fourth, Hefei City actively promotes information sharing and improves the efficiency of government services. Establish a platform for running the government's power list and responsibility list, promote Internet-government services, and strengthen the interconnection and sharing of data and information throughout the city. "Test water" big data means to monitor the economic operation, build a big data platform and put into operation, real-time monitoring of the development of Hefei needs for capital, talent, technology, goods and other development elements flow, to improve the government's scientific decision-making and accurate policy is of great reference value.

5. Concluding remarks

Only the reformer to advance, only the innovator strong, only the reform erstof. Innovation-driven Hefei forward, Hefei independent innovation indicators have entered the national capital city "top ten", with the city competition invincible core competitiveness. Innovation is a highway with no end, building a new type of collaborative innovation ecosystem, Hefei will be faster to take a firm step to build an international influence of the "innovation capital", and strive to make a leading example in the modernization of the five development of Anhui.
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