Dynamics Model of Industry-University-Research Collaborative Innovation System in Logistics Industry under the Background of 'Deep Integration of Informatization and Industrialization'

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Abstract

At present, industry-university-research collaborative innovation in China's logistics industry is increasingly lack of staying power, but also exposed many problems. Therefore, on the basis of studying the scope of influence of the background of "deep integration of informatization and industrialization" on the industry-university-research collaborative innovation in logistics industry, this paper selects a reasonable system boundary, and conducts an in-depth analysis of each subsystem of industry-university-research collaborative innovation and its main interconnected variables as well as the causal relationship between the variables. At the same time, the system dynamics model of industry-university-research collaborative innovation in the logistics industry is constructed through the system dynamics flow diagram, thus revealing the operation mechanism of the industry-university-research collaborative innovation system in the logistics industry.

Keywords

Deep integration of informatization and industrialization; Industry-university-research in logistics industry; Collaborative innovation; System dynamics.

1. Introduction

Industry-university-research collaborative innovation is in the lead and mechanisms under the will of the state, enterprises, universities and research institutions make full use of resources endowment, integrate the advantage resources and implement innovation subject complement each other, the advantages and disadvantages in collaboration to carry out technological innovation, accelerate the transformation of scientific research achievements, to complete its commercialization and industrialization of activity, is the new paradigm of scientific and technological innovation, is also an effective way to collaborative innovation[1]. At present, the measurement of industry-university-research collaborative innovation by domestic and foreign scholars mainly focuses on the evaluation of cooperative performance[2-3], among which the application of system dynamics method to the study of industry-university-research collaborative innovation is an important research method. Dongsheng Yang et al. established a system dynamics simulation model of the basic characteristics and evolution rules of the industry-university- research cooperation, and verified the influence rules of factors such as the dominant position of enterprises in the industry-university-research cooperation and the proportion of R&D investment on the process of the industry-university-research cooperation[4]. By establishing the system dynamics model of regional innovation system, Jian Yang et al. analyzed the circular feedback mechanism of talents, knowledge and capital in the innovation system[5].

At present, China and various regions are vigorously promoting the deep integration of informatization and industrialization. As a modern service industry, logistics industry is also

gradually forming a modern logistics system with new technology and new management as the core. Meanwhile, in recent years, with the development of economy and society, the requirements for the combination of industry-university-research in logistics industry have been constantly improved, but the collaborative innovation performance of China's logistics industry is relatively low. At the same time, there are few literatures on the quantitative analysis of the performance of industry-university-research by scholars. Therefore, under the background of "deep integration of informatization and industrialization", this paper adopts the method of system dynamics to measure and evaluate the subsystems and main variables in the industry-university-research collaborative innovation process of logistics industry, so as to clarify the feedback form and control rule of the system.

2. Dynamic Modeling of Industry-University-Research Collaborative Innovation System in Logistics Industry

2.1. Connotation of Industry-University-Research Collaborative Innovation System in Logistics Industry

Logistics industry-university-research collaborative innovation is all parties on the premise of resources sharing or complementary advantages, base on the principle of joint participation, shared achievements and shared risks, in order to jointly complete the contractual arrangement of division and cooperation for a technological innovation, the main form is the R&D cooperation with logistics enterprises as technology demanders and universities/scientific research institutions as technology suppliers. The ability advantages of universities/scientific research institutions are basic research, professional personnel, scientific research instruments and equipment, knowledge and technical information, research methods and experience, and the demand for resources is capital and practical information; the ability advantages of logistics enterprises are rapid commercialization of technology, relatively sufficient innovation funds, production and test equipment and places, market information and marketing experience, the demand for resources is the basic principle knowledge and scientific and technological human resources. Compared with the collaboration among enterprises, the non competitiveness of interest acquisition is the advantage of logistics industry-university-research collaborative innovation and the key is to select multiple interest points and reach interest distribution rules[6].

2.2. Determination of System Boundary

System dynamics has the characteristics of integrity, openness, predictability and dynamics, and has been widely used in the study of complex coupling systems such as society, economy and environment since it was proposed[7-8]. System dynamics considers that the internal cause determines the behavior of the system, and the external cause often does not play a decisive role. Therefore, it is very important to choose a reasonable system boundary for the model construction of logistics industry-university-research collaborative innovation system. Under the background of "deep integration of informatization and industrialization", the integration of logistics industry, as a modern service industry, with informatization and industrialization, will become a development trend, and the collaborative innovation of logistics industry-university-research will usher in a new development space. With the continuous development of information technology, universities and scientific research institutes also carry out various innovative research, so that various advanced technologies can be widely used in the logistics industry, and provide more and more low-cost, efficient, diversified and lean logistics services for the majority of production and distribution enterprises. In terms of financial support, the government not only increases the support for related projects, but also drives more social capital to participate in the development of

"integration of informatization and industrialization", thus playing a great incentive role in the collaborative innovation system of the whole logistics industry-university-research. In terms of talent support, various regions have launched talent introduction plans, and encouraged universities and enterprises to set up R&D bases, which also attracted more talents to participate in the logistics industry-university-research collaborative innovation system activities. Based on the analysis of the influence range of the above "deep integration of informatization and industrialization" on the industry-university-research collaborative innovation in the logistics industry, this paper divides the industry-university-research collaborative innovation system into the subsystem of innovation achievement formation and transformation, the subsystem of innovation capital circulation and the subsystem of talent flow. At the same time, the three subsystems jointly determine and maintain the operation of the logistics industry-university-research collaborative innovation system through the interconnection and mutual influence of key variables such as innovation achievement, innovation income, innovation capital investment, innovation network attraction and innovation system synergetic degree.

Among them, the innovation achievement is the ultimate goal of the logistics industry-university-research collaborative innovation system. It mainly includes various intellectual forms such as patents, technologies, experiences, academic papers and works. Innovation income is the embodiment of the value of the system. Collaborative innovation results can only reflect its value when the innovation income is generated through the technology market transaction or commercialization and industrialization, and the innovation subjects have the willingness and motivation to further cooperate in innovation. Innovation capital input is a powerful guarantee for the system. With sufficient financial support, the innovation activities of all parties in the logistics industry-university-research collaborative innovation system can be carried out normally, and the R&D personnel can have no worries. The innovation network attraction is the basic support of the system, which is closely related to the benefits obtained from the innovation system. The synergetic degree is an index to measure the harmoniousness of the system. It reflects the depth and breadth of cooperation among members of the collaborative innovation system, and reflects the efficiency and innovation ability of the logistics industry-university-research collaborative innovation system to a certain extent.

2.3. Causal Diagram

The number of innovation achievements, innovation income, innovation capital investment, innovation network attraction and synergetic degree of innovation system in logistics industry-university-research collaborative innovation system are important variables to maintain the normal operation of collaborative innovation network system, and make each node interact and influence each other. Multiple feedback loops are formed among these elements, and a virtuous cycle dynamic process is formed through the transformation and formation mechanism of innovation achievements, the circulation mechanism of innovation funds and the flow mechanism of talents, as shown in figure 1.

From the causal relationship in figure 1, we can see that the industry-university-research collaborative innovation system in the logistics industry is a very complex network. In this network, the collaborative innovation achievements form the income of collaborative innovation system through authorization, transfer or industrialization, to safeguard the interests of members of the system, strengthen the incentive effect of the members in the system. On the one hand, it can improve the popularity of the innovation system, attract more system members to join, and the participation of more system members provides a possible for expanding innovation system influence and shaping a good image. On the other hand, the improvement of the enthusiasm of system members is conducive to giving play to their professional expertise, innovation potential and sense of cooperation, which further enhances

the cooperation degree of the innovation system. In addition, once the attraction of the innovation system is significantly improved, each innovation related subject will invest more human, material and financial resources for collaborative innovation activities and provide more material guarantee. The increase of innovation funds, the expansion of the number of system members, and the enhancement of the synergy degree of the innovation system jointly promote the production of more collaborative innovation achievements. The collaborative innovation achievements are the ultimate goal of the industry-university- research collaborative innovation system in the logistics industry. If the innovation achievements can adapt to the changes of market demand, the innovation subjects in the system can obtain relevant innovation income to maintain operation of the whole innovation system.
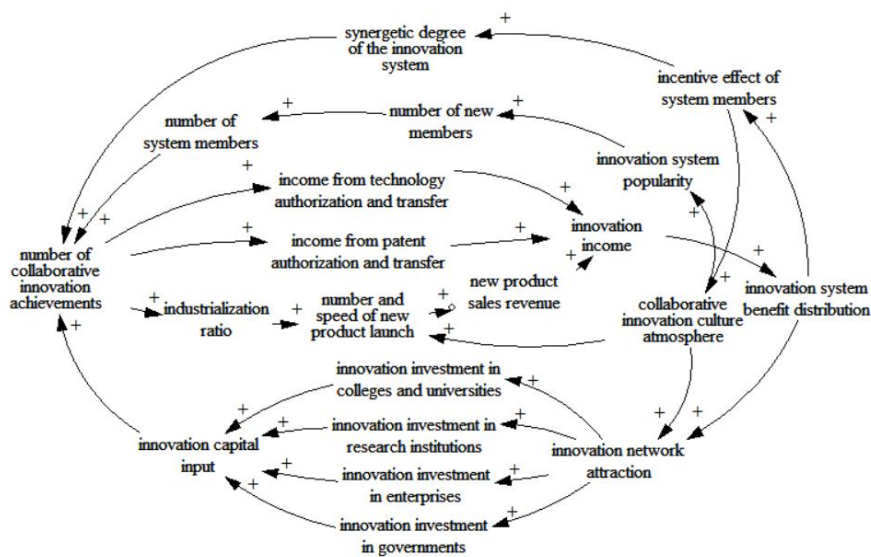

Fig 1. Causal diagram of industry-university-research collaborative innovation system in the logistics industry

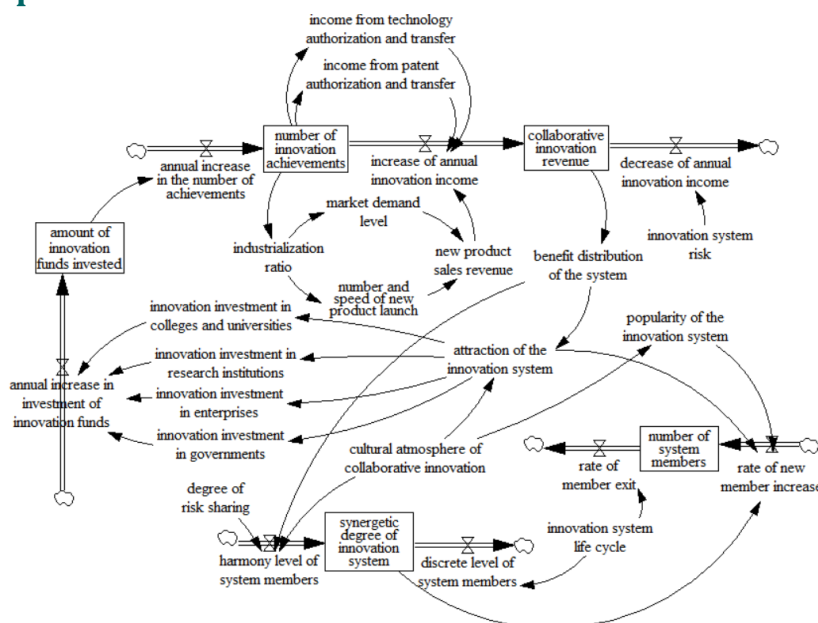## 2.4. System Operation Mechanism

Fig 2 Operation mechanism of industry-university-research collaborative innovation system in the logistics industry

By analyzing the causal relationship between the elements and the main circuits of the logistics industry-university-research collaborative innovation system, we have grasped the relationship and interaction between the internal variables of the innovation system. On the basis of further distinguishing the properties of these variables, the stock flow diagram of the industry-university-research collaborative innovation system in the logistics industry is constructed, as shown in figure 2. The stock flow diagram describes the logical relationship between the system elements more intuitively, clarifies the feedback form and control rule of the innovation system, and reveals the operation mechanism of the industry-university-research collaborative innovation system in the logistics industry.

In the logistics industry-university-research collaborative innovation system, the number of innovation achievements, innovation income, innovation capital investment, innovation system attractiveness and innovation system synergetic degree are five important state variables. These state variables are connected with each other through a number of auxiliary variables and rate variables, forming a whole, which constitutes the operation mechanism of the industry-university- research innovation system in the logistics industry. Among the auxiliary variables, the industrialization ratio of innovation results, the benefit distribution of the innovation system and the popularity of the innovation system are all very important. They not only serve as the link between various state variables, but also serve as the key node of the connection between various subsystems. In addition, the culture atmosphere of collaborative innovation is also very important, but is often overlooked. And in the process of "deep integration of informatization and industrialization", information technology and logistics industry will be more and more closely linked. On the one hand, China will accelerate the implementation of national major scientific and technological achievements, give full play to the existing technical advantages of the logistics industry, and focus on the research and development of key technologies, equipment and parts that restrict the sustainable development of modern logistics industry, so as to effectively promote collaborative innovation ability of the logistics industry. This also provides a good collaborative innovation atmosphere for the logistics industry-university-research collaborative innovation system. A good cultural atmosphere of collaborative innovation is the basis of long-term cooperation, mutual trust, risk sharing and mutual respect among the participants in the logistics industry-university-research collaborative innovation system, which is conducive to the sharing of information, the flow of talents and the transfer of knowledge in the innovation system. Therefore, in order to improve the economic growth ability of the logistics industry-university-research collaborative innovation system, the government should play a guiding role, actively cultivate a good innovation atmosphere and enhance the attraction of the innovation system.

3. Conclusions

The logistics industry-university-research collaborative innovation system is a high-level complex social system with multiple circuits and a large amount of information flow. In this paper, by establishing the system dynamics model of logistics industry-university-research collaborative innovation system, and under the background of "deep integration of informatization and industrialization", the logistics industry-university-research collaborative innovation system is divided into three subsystems: the formation and transformation of innovation achievements, the circulation of innovation funds and the flow of innovative talents. The causality and main loop of the key variables in the system are also analyzed and discussed. Lastly, we discuss the logistics industry-university-research collaborative innovation system operating mechanism. In conclusion, the key to improving the economic growth capacity of the industry-university-research collaborative innovation system in the logistics industry is to integrate the interactive relationship among the human resources, material resources and

financial resources within the system, broaden the channels of revenue growth and cultivate the cultural atmosphere of collaborative innovation, so as to maintain the healthy and sustainable operation of the industry-university-research collaborative innovation system in the logistics industry.

Acknowledgments

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